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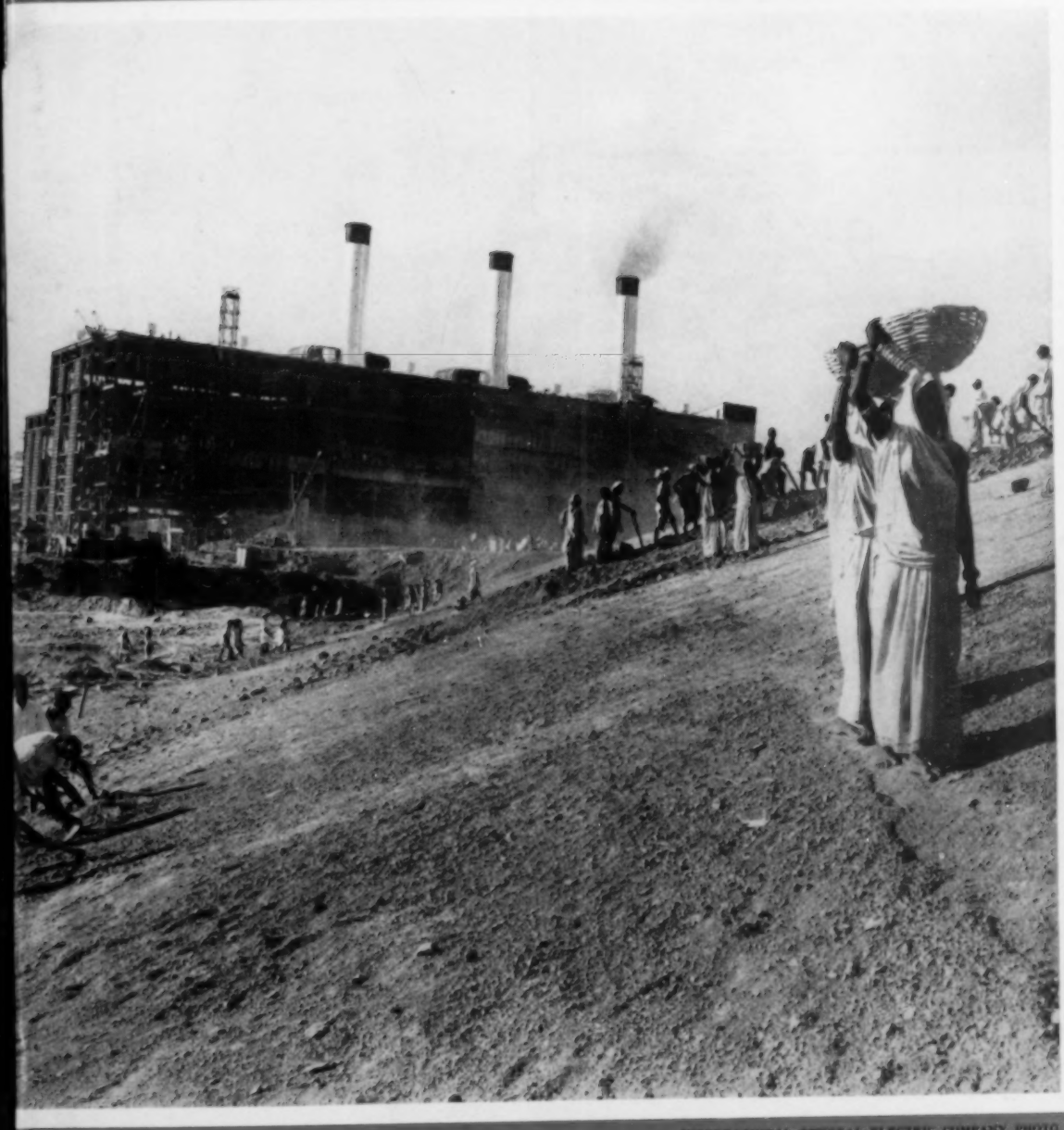
Compressed Air Magazine



INTERNATIONAL GENERAL ELECTRIC COMPANY PHOTO

LARGEST POWER PLANT IN ASIA

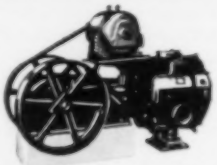
New Bokaro Steam Station In India Is Orient's Most Modern Unit

VOLUME 58 • NUMBER 5 NEW YORK • LONDON

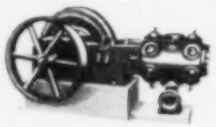
HEAVY-DUTY
"ES" COMPRESSORS

provide maximum efficiency in a
WIDE RANGE OF APPLICATIONS

. . . with unusual flexibility of drive and cylinder arrangements



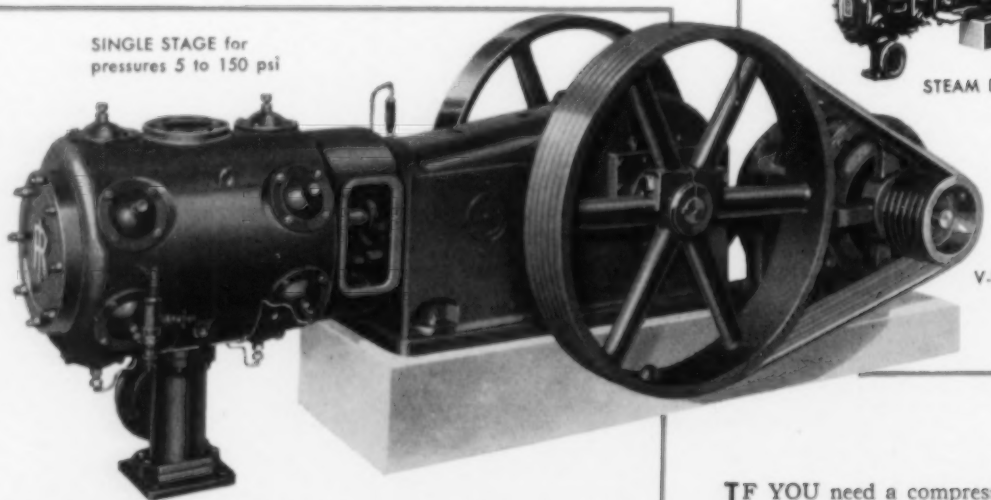
OVERHEAD MOTOR



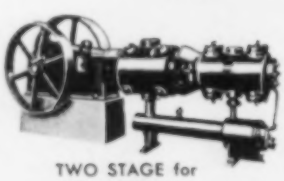
DIRECT-CONNECTED SYNCHRONOUS MOTOR

STEAM DRIVE

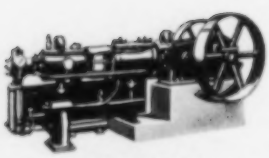
SINGLE STAGE for pressures 5 to 150 psi



V-BELT DRIVE

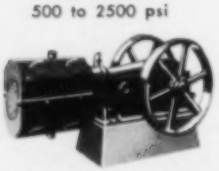


TWO STAGE for 150 to 500 psi

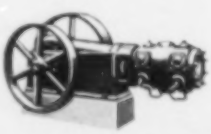


THREE STAGE for 500 to 2500 psi

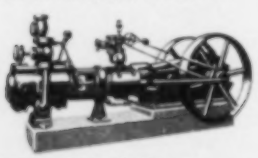
DRY VACUUM PUMPS . . . single or two stage



STEAM-PRESSURE BOOSTERS



NON-LUBRICATED CYLINDERS for oil-free air or gas



REFRIGERATION UNITS for ammonia or other refrigerants

IF YOU need a compressor for any of the following purposes you should consider the Type "ES" compressor . . . a standardized, yet extremely flexible compressor built by Ingersoll-Rand, the pioneer compressor builder.

- To compress air or gas to any pressures between 5 and 2500 psi, or for pulling vacuums. (Stock cylinders are normally available for all frame sizes, see illustrations.)
- For capacities requiring from 5 to 125 horsepower. (Six frame sizes are available.)
- For continuous full-load operation day after day, week after week.
- For handling poisonous, inflammable, or other gases where leakage must be avoided.
- Where compressed air or gases must be free of all traces of oil. (Type NL cylinders require no oil, glycerine, grease or water for lubrication.)
- Where a future change in pressure conditions may call for a change in cylinder sizes.
- Where power cost is an important factor.
- To act as an economical standby unit for larger compressors whose full capacity is not required at all times.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. *Offices and Agents throughout the World* 859-1

COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

STAYNEW INTAKE FILTERS GIVE

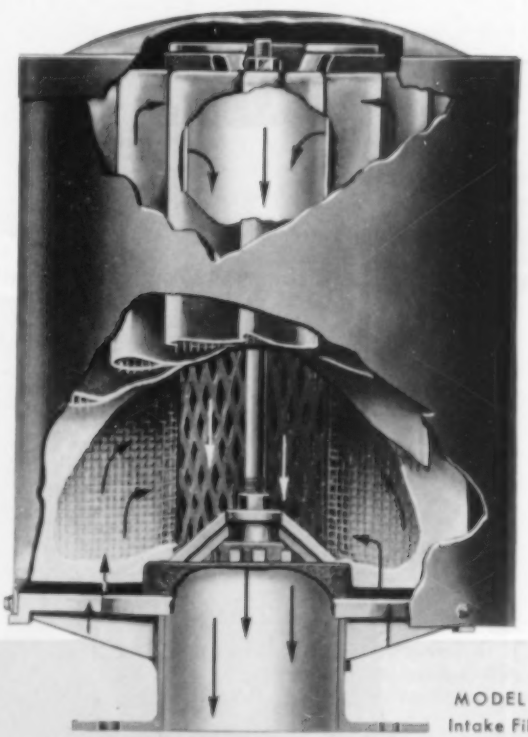
GREATER EFFICIENCY *plus* POSITIVE PROTECTION

IT'S A FACT! A filter which is 99.9% efficient is *9 times* as effective as one that is 99.0% efficient. Why?—because the filter that is 99.9% efficient lets only *one-ninth* as much dirt into the engine. And, it's the dirt that *gets in* that causes the trouble.

The extreme efficiency of Staynew Intake Filters provides *positive protection*—keeps shutdowns and repairs at an absolute minimum. Efficiency actually increases with use. Staynew Intake Filters are efficient over a wide range of loads and are not affected by temperature changes. And, Staynew Intake Filters effectively protect vital engine parts without carefully held maintenance schedules . . . frequently operating two or more *years* without attention.

Get all the facts. Write today for Bulletin S.I.F.

Representatives in Principal Cities



MODEL D
Intake Filter

DOLLINGER PROTECTS YOUR STAYNEW FILTERS

DOLLINGER CORPORATION

7 Centre Park, Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

WHAT *Life-Line* REALLY DELIVERS IS MORE SERVICE...LESS SERVICING

"Whips Trouble Spots" Say users of these *Life-Lines*

"Neither Vibration Nor Moisture Are Problems Now," says the Richard Ore Co. "We installed 7 Westinghouse Life-Linestarters® in a particularly difficult application, a mine concentrating mill. We were off to a flying start immediately—the Westinghouse Life-Linestarter is easier to install because of straight-through wiring and the arrangement of breaker and starter in a single enclosure. Outages due to moisture and vibration have been virtually eliminated. That had been our biggest headache . . . more Life-Lines will be installed shortly."

"No Motor Failures of Any Kind, Now," says Watchcase Manufacturer. "Our punch-press motors were 14 feet off the floor . . . just high enough so that lubrication was often 'forgotten'. Frequent bearing failures and burnouts resulted until we 'perched' pre-lubricated Life-Lines up there two years ago. Since then . . . no failures of any kind. We've standardized on Life-Lines."

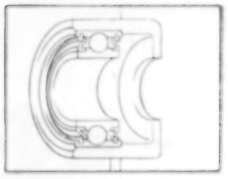
"Straight-Through Wiring Answered My Problem," says the Baker Refrigeration Corp. "We have a new air-conditioning design that requires the use of two starters. We found that the Westinghouse Life-Linestarter could be more easily mounted in a group within our enclosure—saved assembly labor. This completely sold me on your straight-through wiring."

"Increase Bearing Life 8 Times," says Oak Hill Firebrick Co. "We were using sleeve-bearing motors on a shaker screen in a firebrick plant. Bearings never lasted over six months. Life-Lines installed over four years ago have been running 16 hours a day ever since. Pre-lubricated bearings have been perfect."

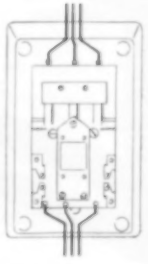
Typical? Yes. Typical of hundreds of reports in every industry. Why not install these dependable partners on your machines? A check with your Westinghouse representative will bring you full details. Ask for copies of "Life-Line Motor Case History Book", B-4769-A and "Tomorrow's Starter Today", B-4677, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21697-A

YOU CAN BE **SURE**...IF IT'S

Westinghouse



Needs no lubrication. Pre-lubricated, factory-sealed bearings eliminate troubles due to under or overlubrication, dust and dirt.



Straight-through wiring. Three line terminals at top; three load terminals at bottom—all easily reached from front.

Bonderite-protected starter enclosure. Anchors enamel as if it were part of steel itself. Finish will not blister or corrode.

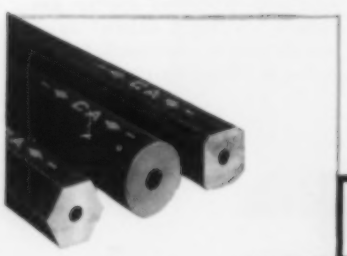
THE DRILL DOCTOR *CRUCIBLE HOLLOW DRILL ROD teamwork in specialties*

The modern, pneumatic rock drill beats out as many as 2000 violent impacts a minute. The man responsible for keeping these drills operating at top efficiency 'round-the-clock is the busy *drill doctor*.

With the high cost of labor and new equipment he knows that to provide good service his drill must be made of the finest steels obtainable. That's why he counts on Crucible.

For Crucible Hollow Drill Rods have demonstrated time and time again their ability to take it . . . to withstand the severest punishment with minimum breakage and bit loss. And Crucible mills are among the few that produce steels that meet the rigid requirements of the rock drill piston — a part that undergoes the toughest service known for steel.

To get the lowest cost per foot per hole in rock drilling, specify Crucible Hollow Drill Rods.



CRUCIBLE first name in special purpose steels

53 *years of* Fine *steelmaking*

HOLLOW DRILL RODS

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Let air give your production problems a lift

Yes, let the tireless muscles of *air power* do your heavy work for you—let air be the force for pushing or pulling . . . lifting or lowering . . . opening or shutting in your plant.

Air is quick, convenient — and it will save you money, too. Try Schrader Air Cylinders to give you that push . . . or pull . . . or push *and* pull smoothly, quickly, and with less work than any other method you've ever tried.

Schrader Air Cylinders are ideal for any application where you need straight-line forces for any distance from inches to feet . . . at forces from less than 20 pounds to over 5,000 pounds. And they pack more power for their size and weight than any other commonly used type of power unit.

So—wherever you need a hefty push—or a gentle shove—or anything in between—think of Schrader Air Cylinders.

The possible uses of Schrader Air Cylinders in industrial plants are so numerous that it is impossible to do more than suggest their great utility and versatility. We'll be glad to give you specific recommendations, however, if you'll just write, outlining the processes used in your plant—or fill out the coupon below.

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control the air

Air Cylinders • Operating Valves • Press & Shear Controls • Air Ejection Sets • Blow Guns • Air Line Couplers • Air Hose & Fittings • Hose Reels • Pressure Regulators & Oilers • Air Strainers • Hydraulic Gauges • Uniflare Tube Fittings

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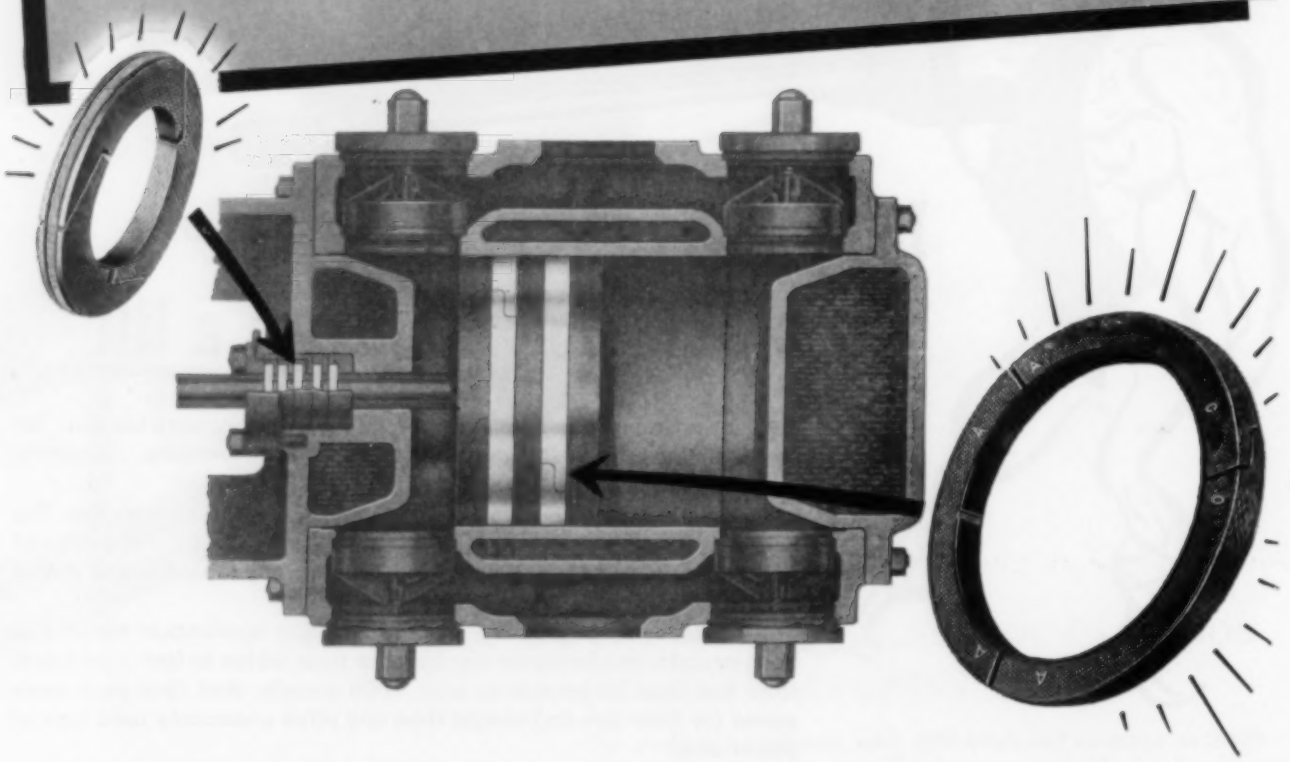
Corrosive gas conditions call for COOKROC Packing and Piston Rings



COOKROC rings have established a record for dependable, troublefree service in compressors handling gases with high H_2S concentrations and gases burdened with hydrocarbon vapors.

Their successful performance is due to two basic factors. First, they are made of Laminated Bakelite, a hard, dense and durable material which is extremely resistant to the attack of corrosion and which has topflight bearing qualities. Second, they are manufactured under the same high standards of precision and workmanship that have made Cook Metallic Packings and Piston Rings the choice of compressor operators and builders the world over.

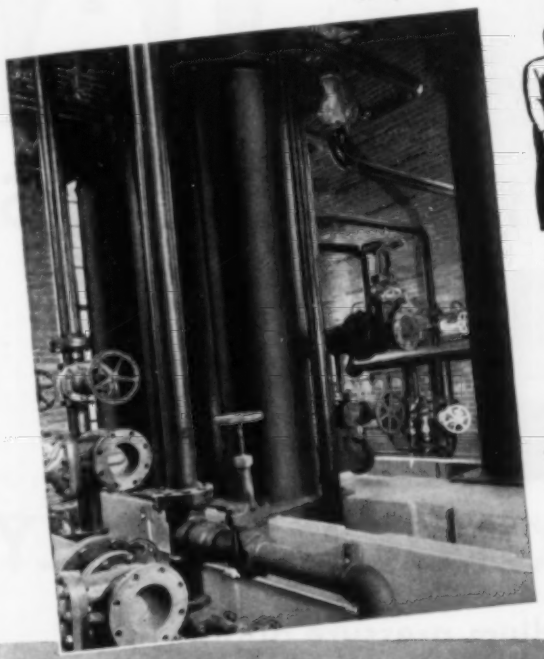
AT THE INTERNATIONAL PETROLEUM EXPOSITION see these and other Cook piston rings and packings at BOOTHS No. 51 and 52 in the Texas Building. C. Lee Cook headquarters will be located in the Tulsa Hotel in Tulsa.

C. Lee Cook Mfg. Co., Incorporated, Louisville, Ky. Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

. . . SEALING PRESSURES SINCE 1888 . . .

Dirty Water can't "Shut-down"...

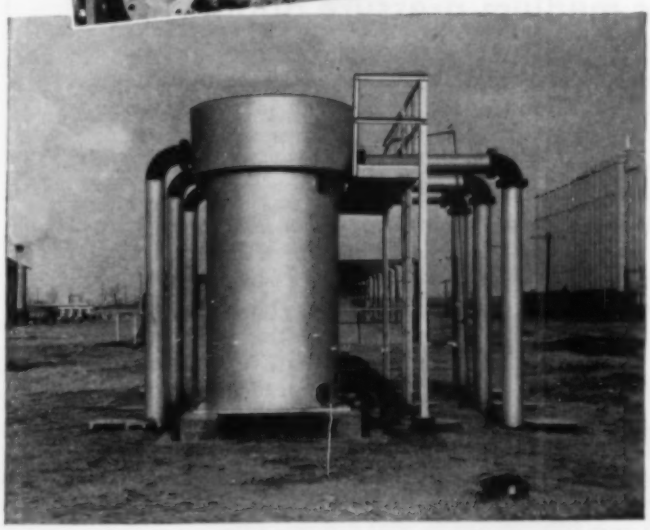
Vogt



film type exchangers

(Condensers—Coolers—Evaporators)

Patent Nos. 1,935,270 - 2,057,597 - 2,424,441



River water, well water or brackish water are all alike to this exchanger *because it can be cleaned* while in operation! The water distributing ferrules need only be removed successively for the cleaning brush or tool whereby the tubes receive additional water which sluices away the dislodged dirt.

Vogt Film Type Exchangers are operating with real economy of first cost, operation and maintenance in power, petroleum, and chemical industries. They serve as Jacket Water Coolers, Feed Water Heaters, Hydrocarbon Evaporators, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to cool or heat any liquid and to condense or evaporate any fluid.

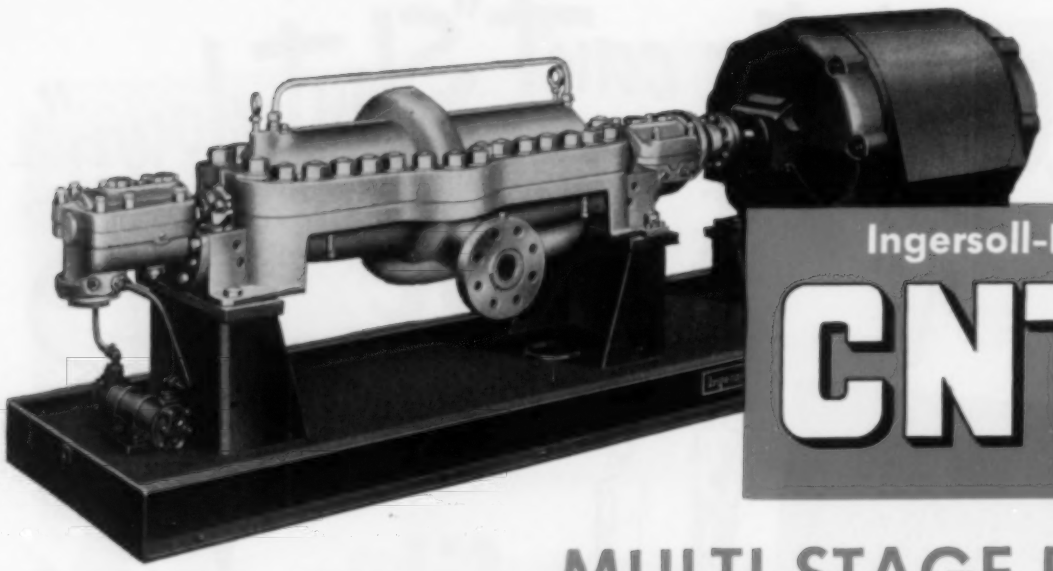
TOP: *Four units at Newton Falls, Ohio Municipal plant cool water for diesel engines and a lubricating oil cooler.*

BOTTOM: *Jacket Water Coolers serving engines of 7,300 HP in the compression plant of a Western Oil Refinery.*

[Bulletin HE-7 describes typical installations of Vogt Film Type exchangers and is available upon request.]

HENRY VOGT MACHINE CO., LOUISVILLE, KY.

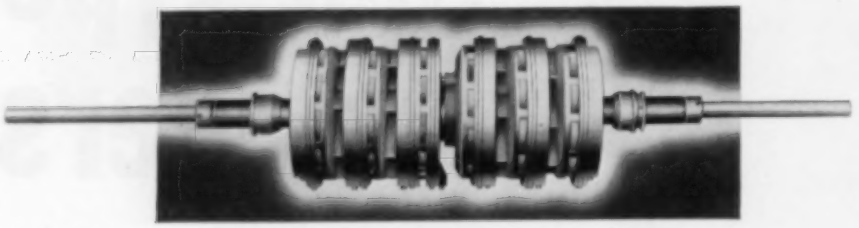
Branch Offices: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.



Ingersoll-Rand

CNTA

MULTI-STAGE PUMPS



extend the advantages of the

UNIT-TYPE ROTOR ASSEMBLY

HIGHER SUSTAINED EFFICIENCY

Greater simplicity of design, with precision-matched impellers and channel rings, permits unusually high efficiency which is sustained throughout years of operation.

GREATER DEPENDABILITY

Radial balance with multiple-volute design and axial balance with opposed impeller grouping, assure long trouble-free operation. The smooth-bore, symmetrical outer casing eliminates any possibility of distortion under high temperature operation.

REDUCED MAINTENANCE

Entire rotor assembly can be removed from the casing as a single, compact unit, without disturbing piping connections. There are no ring fits to align on replacement of the rotor assembly.

to your medium pressure applications

• With the completely re-designed line of CNTA multi-stage pumps, Ingersoll-Rand offers a new high in performance, efficiency, dependability and economy—for medium-pressure boiler feed, mine dewatering, marine, petro-chemical and general hydraulic services.

The advanced design Unit-Type rotor assembly, with impellers and channel rings mounted on a single, heavy-duty shaft and with a smooth-bore outer casing, is the same type as that used by Ingersoll-Rand in the high-pressure CHTA and HMTA lines. The result of this modern construction is a dependable, simpler and more rugged unit that requires minimum attention and maintenance.

CNTA pumps are multi-stage, horizontally split units, with single-suction impeller groups placed back-to-back to eliminate hydraulic thrust. They are available in 4, 6 and 8 stages for pressures from 100 to 800 psi, in capacities from 50 to 700 gpm.

Your I-R representative will be glad to give you the *complete story.*

Ingersoll-Rand

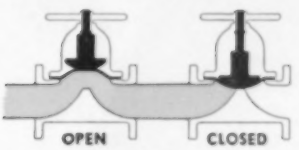
Cameron Pump Division
11 Broadway, New York 4, N. Y.

844-10

COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · DIESEL AND GAS ENGINES

The valve originally designed to eliminate

COMPRESSED AIR LEAKS



Features which have made Grinnell-Saunders Diaphragm Valves the specified valve in many different industries:

Streamlined flow. Smooth, streamlined passage, without pockets, prevents trapping of solids. Frictional resistance is at a minimum — regardless of direction of fluid flow. No disc holder in fluid stream.

Leak-tight closure against grit, scale, suspended solids. The resilient diaphragm, plus the large area of contact, gives leak-tight closure against pressure or vacuum.

Working parts absolutely isolated from fluid. Diaphragm completely seals off working parts from fluid in the line. No sticking, clogging or corroding of working parts. Valve lubricant cannot contaminate fluids.

Body, lining and diaphragm materials to meet service condition. Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum; other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

Minimum maintenance. No refacing or reseating is required. No packing glands to demand attention. New diaphragm can be inserted without removing valve body from the line.

Quick Operating Valve

Write for Grinnell-Saunders Diaphragm Valve Catalog.

A single 1/32-inch leak in an air valve can waste, in one month, the full cost of a Grinnell-Saunders Diaphragm Valve. In fact, that's why Grinnell-Saunders Diaphragm Valves were designed . . . to eliminate costly air leaks. Even when scale in the line becomes lodged on the valve weir, Grinnell-Saunders Valves give positive, air-tight closure.

The operating principle is simple. A rubber diaphragm, seating on metal, makes possible an absolute seal. At the same time, because working parts are wholly isolated, no packing glands are necessary, and stem leaks are impossible.

Successful on compressed air lines, it was only a matter of time before Grinnell-Saunders Diaphragm Valves were in demand for other type installations . . . handling materials as diversified as corrosive fluids, gases, beverages, foods, suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

Grinnell-Saunders Diaphragm Valves can be had with body, lining and diaphragm materials to meet different service conditions. Assign your next valve problem to Grinnell.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
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"Tops" in the tight spots!

TOLEDO Drop Head Tools

save time, cut costs . . . in corners or anywhere!

Handy for close corner jobs. These popular Toledo Ratchet Threaders are small, light, compact. Produce clean-cut threads easily . . . anywhere!

Quick change of sizes. Die heads drop into ratchet from either side, held securely.

Dies of finest tool steel. Precision-ground. Die segments can be re-ground when dull or replaced at small expense. Three models: No. 00—⅛" to ¾"; No. 11—⅛" to 1¼"; No. 12—½" to 2" pipe.

Order through your Supply House. Write for catalog 11a52. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.

RELY ON THE LEADER

TOLEDO

PIPE TOOLS . . . POWER DRIVES . . . POWER PIPE MACHINES

Carving through hard limestone on U. S. 22 By-pass

▲ **SLICING THROUGH**—This hill of solid rock, cut to a maximum depth of 55 ft below grade, calls for drilling and blasting 70,000 cu yd of tough limestone. Floyd Coveney is job superintendent for the contractor. Russell E. Boyer is District Engineer for Pa. Dept. of Highways.

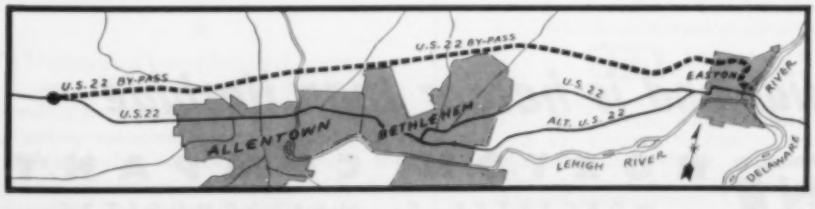
◀ **FROM THE AIR**—Looking west, the by-pass takes shape in early January. The 1.1 mile section, between arrows, skirts the boundaries of Easton Cemetery along winding Bushkill Creek. Lafayette College is in the right foreground.

▼ **HARD LIMESTONE**—The wagon drill crew hoists a long rod of Bethlehem Hollow Drill Steel into position for drilling. Holes up to 18 ft in depth are drilled with carbide-tipped bits.

One of the toughest sections under construction on U. S. 22 By-pass in eastern Pennsylvania is a 1.1 mile stretch within the city of Easton. This $729,600 contract, held by Central Pennsylvania Quarry, Stripping & Construction Co. with the Pennsylvania Department of Highways, calls for excavating, drainage and paving two 24-ft roadways immediately west of an elevated approach to the bridge over the Delaware River. Completion of the contract is expected by September.

Nearly all of the 277,000 cu yd of excavation is limestone so tough that tungsten-carbide-tipped bits must be used in drilling an estimated 130,000 ft of hole. "Central Penn," with headquarters in Hazleton, Pa., has been a steady user of Bethlehem Hollow Drill Steel for 20 years. "It's always been satisfactory," says John B. Bruns, general superintendent.

▼ **RELIEF FOR HEAVY TRAFFIC**—About 22.5 miles of the 4-lane by-pass is now under construction, from the Delaware River at Easton to a point west of Allentown. Its completion will bring much-needed relief for heavy traffic which flows between Harrisburg and New York.



BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL

BETHLEHEM STEEL

Hundreds of hours longer...

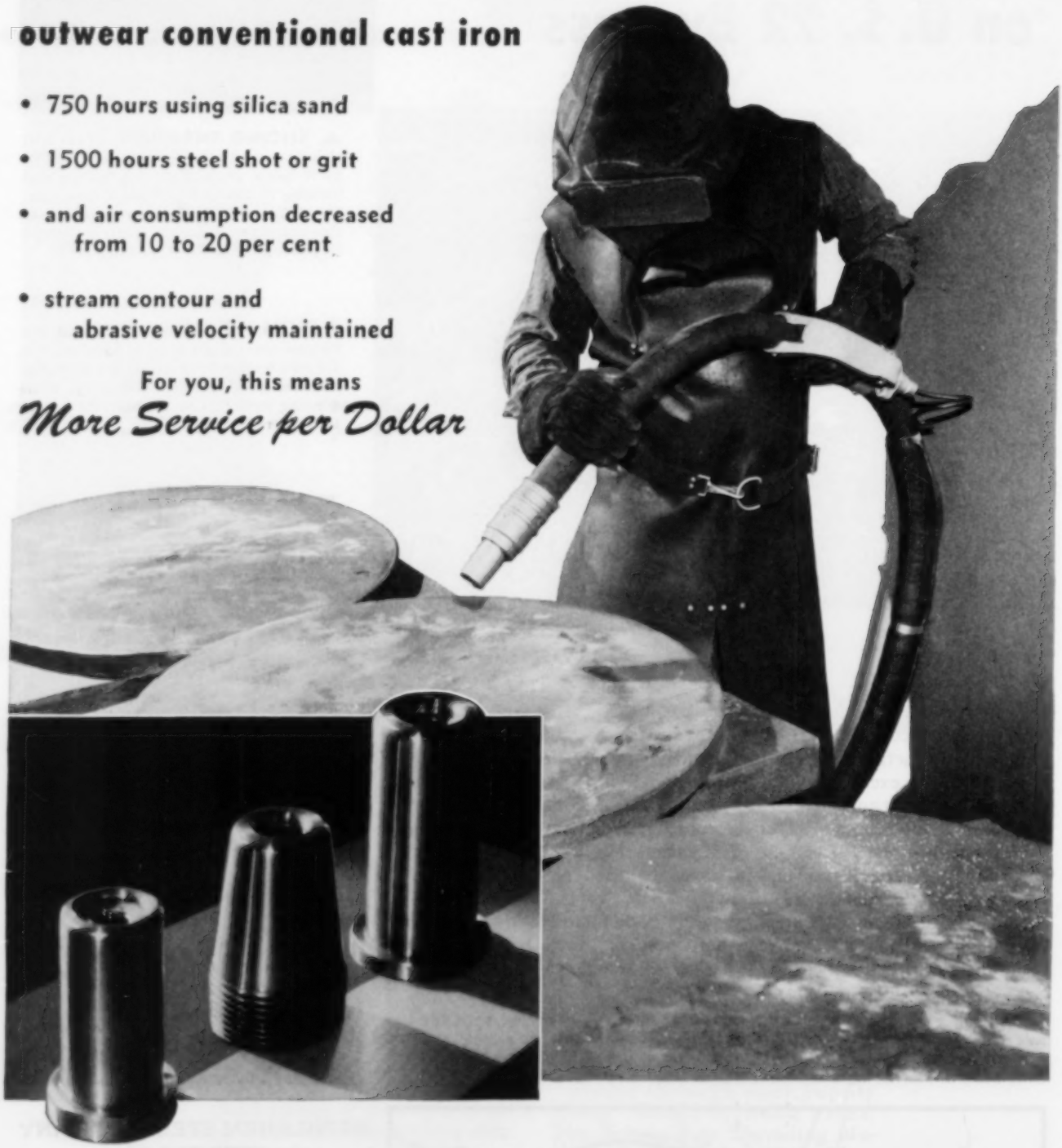
NORBIDE® Pressure Blast Nozzles

outwear conventional cast iron

- 750 hours using silica sand
- 1500 hours steel shot or grit
- and air consumption decreased from 10 to 20 per cent
- stream contour and abrasive velocity maintained

For you, this means

More Service per Dollar



Only the diamond is harder than Norbide

NORTON®

NORTON COMPANY

WORCESTER 6, MASSACHUSETTS

Making better products to make other products better

ON THE COVER

INDIA'S new Bokaro electric generating station is as modern as any in existence, but it was built by a curious combination of new and old sources of energy. For some jobs such as heavy lifting, its designer and builder, The Kuljian Corporation of Philadelphia, Pa., used machines, but wherever possible native labor was employed. That course not only reduced the cost of construction but also gave needed work to hundreds of local residents. Our cover picture shows the primitive method used for moving and placing earth on an embankment retaining a waterway leading to the plant from the Konar River.

●

IN THIS ISSUE

INDIA is exerting a tremendous effort to improve the standard of living of her huge population. She is primarily an agrarian nation and a producer of raw materials and will remain essentially that. The current program seeks first to increase the output of the land and then gradually to establish industries that can be based on the abundant agricultural and mineral wealth. It is a manysided program that will require a long time to complete. Our leading article enumerates its salient features and describes some of the initial projects.

●

HARD rock tunnelers are learning that they can in some cases profitably adopt the roof-bolting technique developed by the mining fraternity for supporting unstable ground. The drill carriage that is well-nigh standard tunneling equipment provided a convenient working place for bolting operations in the East Delaware Aqueduct driven by the New York Board of Water Supply. Page 128.

●

DESIGNING engineers strive to reduce or eliminate vibration in most of the machines they devise. Nevertheless, vibration has many helpful applications in industry, and in many instances the equipment by which it is produced is air operated. Page 131.

●

INTERESTING and beneficial services performed by permanent magnets are growing day by day and are found in both homes, hospitals and industrial establishments. Page 136.

●

THE eyes of television that never close are vigilantly watching over an expanding list of industrial operations, safeguarding valuable equipment and insuring unvarying functioning beyond the powers of human eyes and hands. TV, conceived as something other than a means of diversion, is only now fulfilling the hopes of its originators. Page 139.

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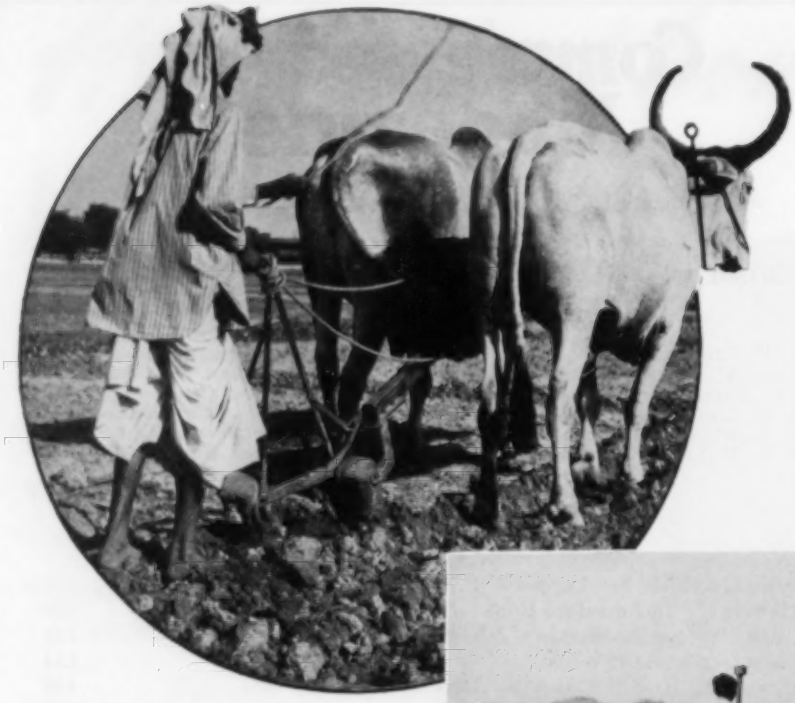


India Builds for Self-Support

Her River-improvement Program the Largest Ever Attempted

C. H. Vivian

GOVERNMENT OF INDIA PHOTOS

CONTRAST

Many of India's plows are drawn by draft animals, much as in Biblical times. However, the plow seen at the top is an improved one introduced by the Agricultural Research Institute in 1949. It consists of the bottom sections of two conventional plows held together by an iron framework and pulled by means of a single central beam. It reportedly does twice as much work as older types and is more stable and hence easier to hold. The other picture shows modern tractors breaking ground in Patheri-Khurai.

INDIA is entering upon a huge program of engineering construction designed to improve the lot of her people. It is a long-range undertaking of such magnitude that it will require decades to complete, but a good start has been made. The effort has even borne some fruit, including the $35 million Bokaro steam-operated power plant in the Damodar Valley which was put in service on February 22.

When India gained her independence, the national leaders took a close look at their country to see where it stood, where it might hope to go, and how it might best expect to get there. This examination showed them, among other things, that the per capita income was only $56 a year and that the nation was annually spending abroad up to $600 million for food and cotton to keep her people from starving and her textile mills running.

After considering how the situation could be ameliorated relatively soon, it was decided that for the time being an attempt should be made to double the individual income and to increase crop production enough so that the huge sums paid year after year to the United States, Canada and Australia for wheat, rice, cotton and other commodities could be kept at home. When possible ways of accomplishing these goals were sought, attention was soon focused on the country's river system. Here, it was plain to be seen, was India's greatest resource and one that, through proper multipurpose development, could be made to provide food and revenue for the agrarian population, as well as raw materials and power for industry.

India's climate favors all-year farming. In almost every section the annual rainfall is sufficient to support plant growth, but nine-tenths of the precipitation is confined to the short monsoon season and runs off in floods, washing away badly needed crops, eroding the land and doing much property damage. The streams' combined yearly flow often reaches 1300 million acre-feet—enough to cover Texas to a depth of 8 feet. It is equally fortunate that the moisture is fairly evenly distributed, one or more rivers passing through nearly every province or major state.

India already has 50 million acres under irrigation—more than any other nation—but so far has brought water only to areas that are comparatively easy to reach and done little towards controlling the floodwaters flowing to the sea. She now proposes to do these things by carrying out the most gigantic river-valley development program ever attempted anywhere.

The possibilities open to the planners are, in fact, so great and so varied that it was difficult to know just where to begin. An over-all survey disclosed that Nature has provided the essentials for fully 160 projects. If all could be undertaken simultaneously they would increase the power-generating capacity by 10 million kilowatts and put irrigating water on enough additional land to boost food production by 10 million tons annually. It would manifestly be impossible, however, to finance such a program in its entirety at one time, especially when it is considered that a substantial percentage of the total outlay would be in foreign money needed to pay for supplies, equipment and tech-

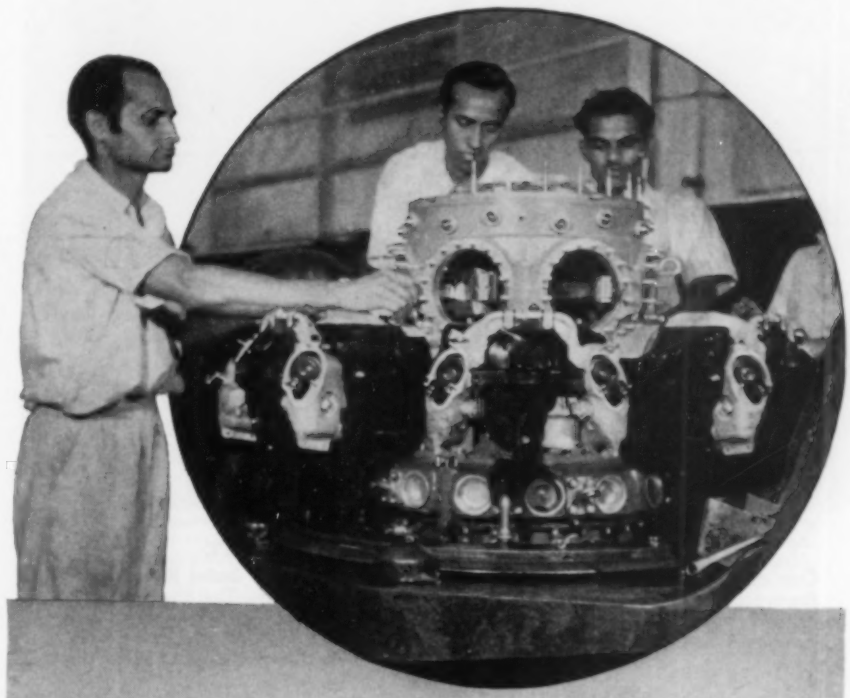
nical services from abroad. Moreover, there would not be a sufficient engineering and labor force available to do the work involved, and the requirements of some key materials such as steel and cement would run into fantastic figures.

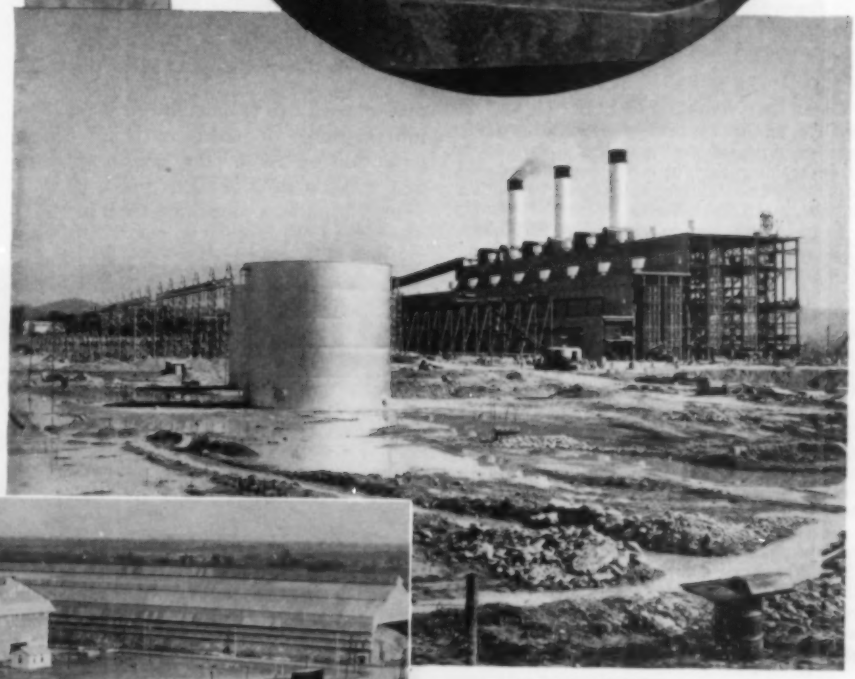
Consequently, it was decided to tackle the job piecemeal under a series of 5-year plans. To proceed in an orderly fashion, a Planning Commission was created and first met on March 20, 1950. Sixteen months later an outline of the first 5-year plan was issued and put into effect almost immediately. It is moving along at an encouraging pace and steadily gaining momentum.

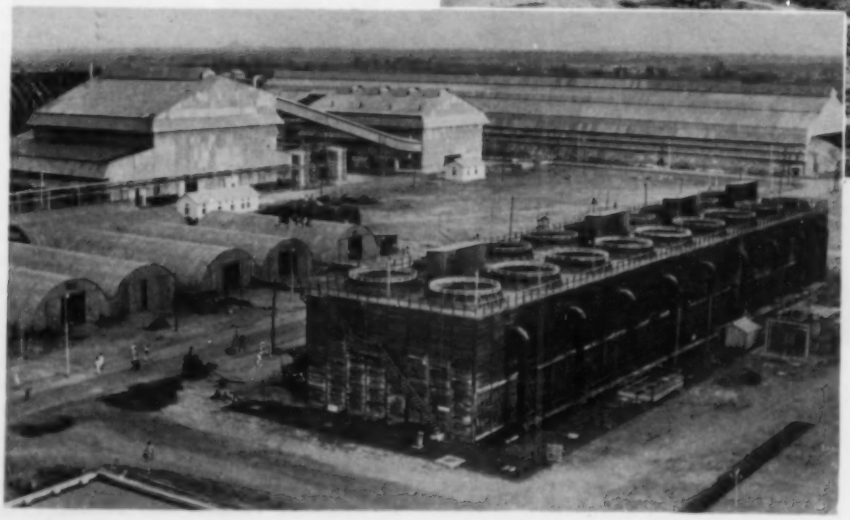
To begin with, 46 of the 160 projects were selected for preferred attention, with emphasis on those that would yield food grains quickly. Behind this decision was the reasoning that it was necessary to supply more food, raw materials and electricity before the establishment of more industries to increase employment and the national income. Stress was therefore placed on irrigation and on power development. Further study made it clear that 46 undertakings would be too big a first bite, and the plan as finally revised and adopted by the Indian Parliament on December 25, 1952, lists 23 major projects grouped under three headings, as follows:

Irrigation and power, agriculture and community development; transport and communications; and social services, employment and miscellaneous. The total cost is estimated at 20,687 million rupees ($4,350,000,000). Of this sum, irrigation and power are given the highest allotment, $1,178,000,000; transport and communications are in second place with $1,043,110.

Just how much of this program can be completed in the time set depends largely upon the success of the financing efforts. It is figured that the Central Government and the various state governments can provide close to 70 percent of the total fund from existing sources of revenue, and it is hoped that external credits can be obtained for the balance. In fact, approximately $328 million has already been received. If these steps fail, taxation and deficit financing may be called upon. The United States Government is furnishing $50 million for eleven specific purposes enumerated in a series of agreements drawn up last June by the Technical Cooperation Administration of the Department of State. India is to contribute $86 million in rupees. The United States funds were allotted as follows:







INDUSTRY

The picture at the top shows workers in the factory of Hindustan Aircraft, Ltd., assembling a Pratt & Whitney engine. Directly above is the nearly completed Bokaro generating station with smoke issuing from one of its stacks (the fourth one had not been erected). At the left is a view of part of the Sindri fertilizer factory, with its powerhouse cooling tower in the foreground. The plant is producing more than 1000 long tons of ammonium sulphate daily.

GOVERNMENT OF INDIA PHOTO

DIVERSION TUNNEL, BHAKRA DAM SITE

One of two 50-foot-diameter bores for the diversion of the Sutlej River during the rearing of Bhakra Dam, on which work is now underway. The Bhakra-Nangal Project, when completed, is designed to generate 400,000 kw and to irrigate 3,600,000 acres of land. Its estimated cost is $273 million.

Community development, $8,671,000. It was also agreed that America would provide some technicians and supplies with a view to increasing agricultural production and improving the living conditions of 12 million Indians in 16,500 villages.

Tube wells for irrigation, $13,700,000. This undertaking contemplates the drilling of about 2000 deep wells each capable of yielding enough water to irrigate 500 acres in the Gangatis Plains in Bihar, Uttar Pradesh, the Punjab and Pepsu.

River development, $4,784,000. This money was earmarked for use in building Hirakud Dam, one of three barriers planned for the development of the Mahanadi River. The structure will store water to generate 400,000 kw of electricity, to irrigate two million acres and also to provide a 380-mile navigable waterway through Orissa to the Bay of Bengal.

Fertilizer imports, $10,650,000; iron and steel imports for agricultural purposes, $8,350,000; fisheries, $2,462,000; locust control, $230,000; soil surveys, $200,000; village-worker training, $166,000; forestry research and desert afforestation, $104,000; malaria control, $648,000.

The largest proportion of the 5-year-plan expenditures for transportation and communication will go towards railroad rehabilitation, and sizable contracts for cars and locomotives have already been placed abroad. The rail lines, which are run by the government, are expected to supply most of the funds they will spend. The plan also envisages constructing 450 miles of new highways and 43 large bridges, improving 2200 miles of roads, and adding aircraft and ships to current fleets. The river-development projects will, it is calculated, bring 8½ million acres of additional land under irrigation by 1956. The goal is to raise 61.6 million tons of food grains in that year, 7.6 million tons more than in 1951.

In the industrial division, it is proposed to let private companies stand most of the cost of expansion, which is estimated at $499 million. Major expenditures in capital-goods lines will be invested in facilities for manufacturing iron and steel, aluminum, cement, fertilizer, heavy chemicals and industrial alcohol and for refining petroleum. In the matter of consumer goods, plants for turning out paper, rayon, and drugs are projected. It is expected that both these fields will attract some foreign private capital, and the Burma-Shell and Standard-Vacuum companies have already agreed to build refineries. Other specific industrial establishments listed and now either in the planning or construction stage include an instruments factory in Calcutta, a telephone-cable works in West Bengal, the Vizagapatam shipyard in Madras, a machine-tool plant in Delhi, a factory near Poona for the production of penicillin and a foundry in Himachal Pradesh.

Although the first 5-year plan is supposed to have started in 1951, some of the projects embodied in it were actually put underway sooner. For that matter, India has been trying for a long time to work out such a program, but internal conditions were against it. Under the terms of the Government of India Act of 1935, each political subdivision was given authority to develop the water resources in its own territory almost as it wished. This resulted in schemes designed purely for local benefit, without regard for the interests of neighboring states.

In an effort to correct this situation,

MODEL OF BOKARO STATION

Coal, which the completed plant will consume at a rate of 200 tons per hour, is transported from nearby strip mines either by aerial ropeway or railroad. At the powerhouse it can be added to the stockpile shown at the bottom or put into station bins for immediate use. The outdoor switching station is at the right of the building and the water intake channel angles off at the top. The model was prepared by The Kuljian Corporation, the plant's designer and builder.

the Central Water Power, Irrigation and Navigation Commission was created in 1945 and gradually became the chief coordinating agency for the development of the waterways. It introduced the principle of treating each river system as a unit regardless of the boundaries of political subdivisions, as is common practice in the United States, Canada and many other countries.

Obviously, considerable planning had been done and some construction begun by the time the initial 5-year plan came into being. The Damodar Valley scheme, for instance, had been launched in 1948 with the formation of a corporation modeled somewhat after the TVA in the United States. A start had also been made on the industrial program, especially on the erection of establishments tied in with the underlying theme, namely, increasing the food-raising capacity. In this category is a large fertilizer factory at Sindri in Bihar that began to operate in March, 1952. Erected at an outlay of $48 million met with British and American assistance, its power plant not only generates enough current for its own needs but also a surplus that is put to good service in the surrounding area.

Also well on the way to completion is the first newsprint mill which is located at Chandni in Madhya Pradesh and scheduled to go into production by mid-year. To cost $10.5 million, it will turn out 30,000 tons annually—reportedly about one-third of the nation's requirement of this grade of paper.

Enough has been done on the river-control program to give an idea of the benefits to be expected. During a drought in 1951 a rubble-masonry dam that had been built on the Mayurakshi River in West Bengal, together with 300 miles of connecting canals, supplied water to save crops on 80,000 acres. By 1952 the acreage under irrigation had been increased to 125,000 and there was sufficient water available to raise two crops.

Four of the principal river-development projects that are being financed mainly by the Central Government are the Damodar Valley Corporation plan and the Hirakud, Harike, and Bhakra-Nangal schemes. The one mentioned last will include the Bhakra Dam, a straight-gravity concrete barrier that is designed to rise 680 feet. Only Hoover among existing dams reaches a greater height (726 feet), but higher ones are under construction in Switzerland. Bhakra Dam will be reared in a gorge where the Sutlej River cuts through the Naina Devi mountain range at a point 220 miles north of Delhi. It will be described more fully in a later article.

The Damodar Valley program calls for the rearing of nine dams on the river and its tributaries, with appurtenant hydroelectric stations having a total capacity of 195,750 kw. However, as it was realized that it would take considerable time to bring these works into service, and as there was an immediate need of power in the area, it was decided to construct a thermoelectric plant at the outset, especially as some of the energy generated by it could be used in building the river structures.

WORK PROVIDED FOR NATIVES

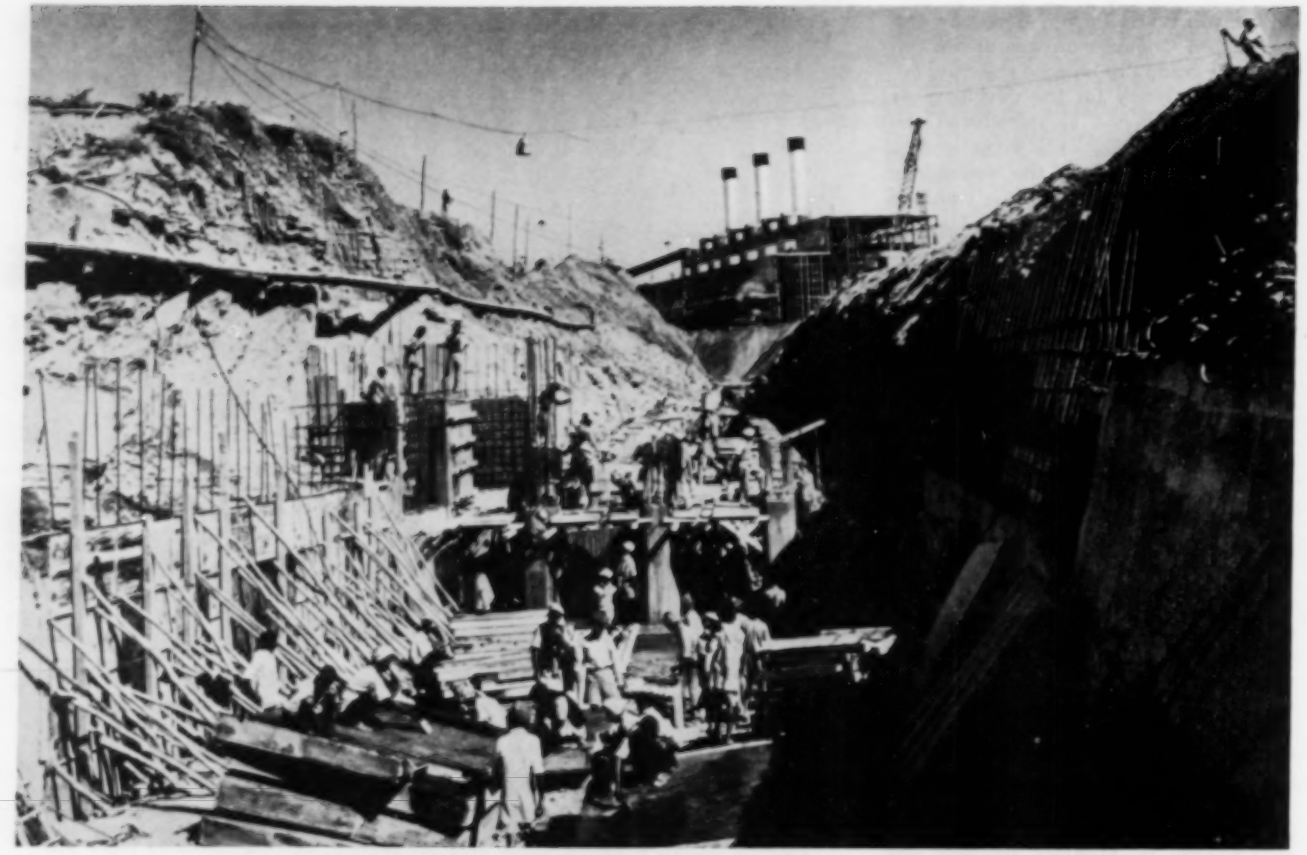
To spread employment and thus contribute to the general welfare of the local communities, it is intended to use native labor whenever it is of advantage, economically or otherwise, to do so. In line with this guiding policy, 2800 natives were employed on the Bokaro Station when construction was at its height. They worked under native supervisors who had been trained by the Kuljian organization. During the excavation of the site, 600 coolies transported rock in baskets balanced on their heads. Natives also cut sandstone for samples of random Ashlar, a task at which they are skilled. In both instances there was not available a better or cheaper way of doing the work.

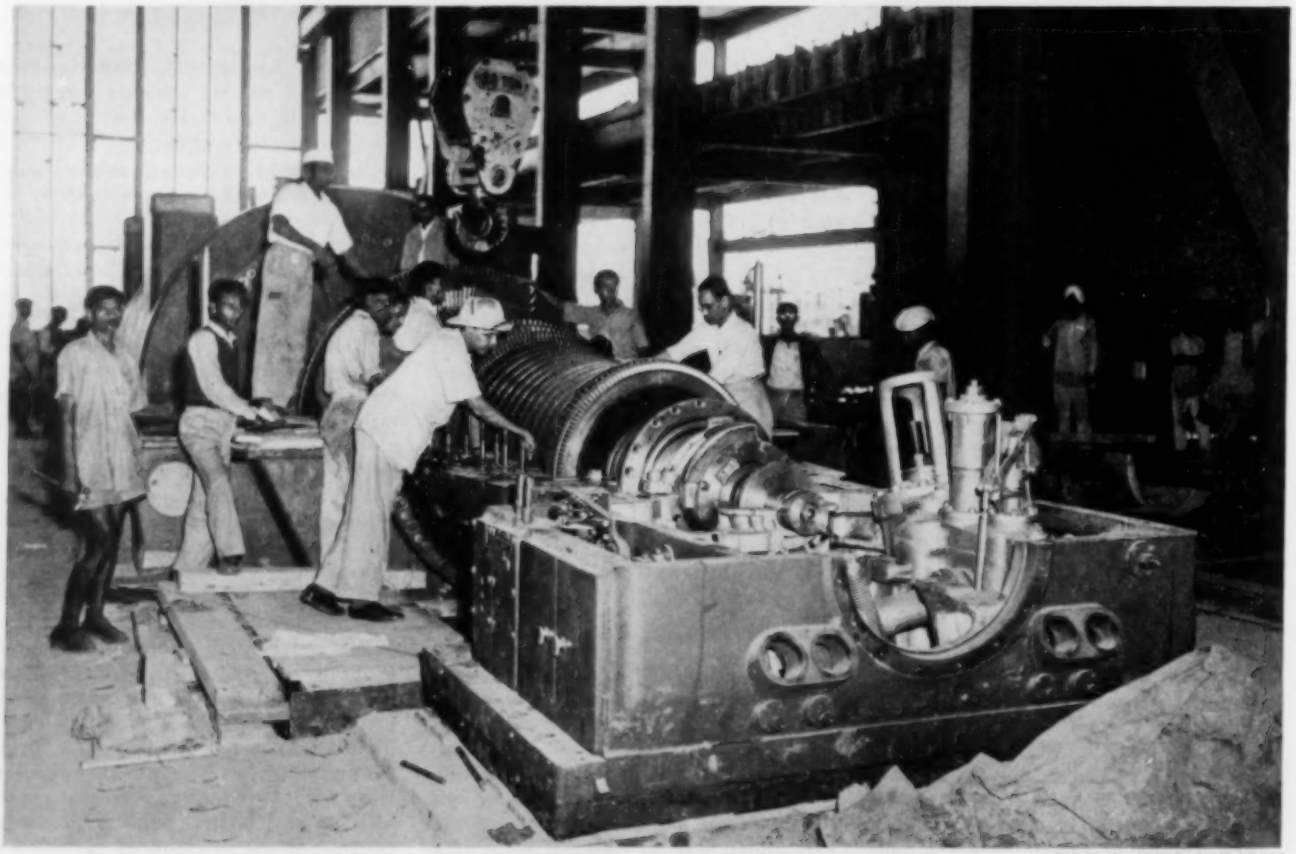
The 330-mile-long Damodar Valley is the most highly industrialized section in India. In it are her locomotive factory, the Sindri fertilizer plant, cement mills and two important iron and steel works. Within its confines or close by are also the country's richest mineral resources, including three-quarters of the coal reserves, 85 percent of the world's best mica, and large deposits of iron, bauxite, manganese, limestone, copper and chrome. The exploitation of these resources through existing or new facilities will be aided by the provision of more power. Meanwhile, work is going ahead on the dams and their powerhouses and on 1550 miles of irrigation and drainage canals that will serve one million acres of farmland in West Bengal.

The Bokaro plant will eventually house four 60,000-kw turbogenerators. One was put in use in February and two more are being added this spring. The fourth will be installed some time in the future. The station is one of the largest in Asia and has the highest operating pressure of any in the Far East. Each of its General Electric generators is supplied hourly with 300,000 pounds of steam at 895 psi pressure and 910°F total heat by two Combustion Engineering-Superheater boilers.

Coal dug in strip mines 2 miles away is brought to the plant either by an aerial ropeway or railway cars and is pulverized before use. For each boiler there are two pulverizers from which the fuel is fed to four burners. Although firing is done with coal only, heavy oil is available for igniting the burners and keeping them functioning in case of hang-ups in the coal-feeding mechanism. The ratio of fuel to combustion air that will give optimum results is automatically maintained by an air-operated control system. The coal has a maximum ash content of 31 percent. Both bottom ash and fly ash are removed by a hydraulic system designed to handle 300 tons an hour and are transported to a fill area near the powerhouse.

Water required to operate the plant is obtained from the nearby Konar River and will total 250,000 gpm when all the generating units are functioning. It is diverted by a low dam into an intake channel 1200 feet long and of sufficiently large cross section or capacity to serve as a settling basin. That is necessary because of the pronounced turbidity of the water during the monsoon season when the river rises as much as 20 feet. Near the station the channel leads into a tunnel at the entrance of which are

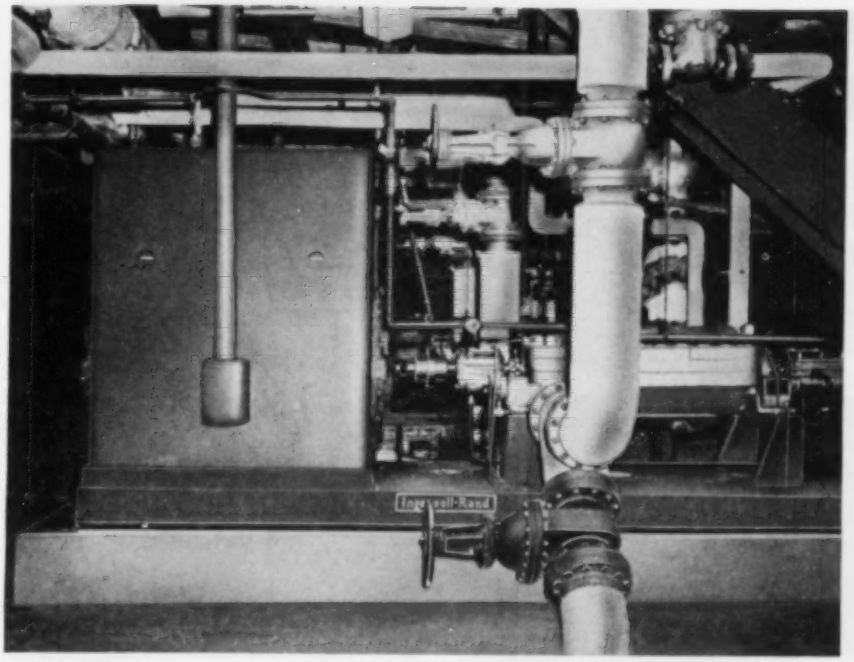




KULJIAN CORPORATION PHOTO

BOKARO CONSTRUCTION SCENES

Pictured at the top are natives building forms preparatory to concreting the channel through which cooling water now flows to the plant from the Konar River. The other view shows the turbine rotor of No. 3 generating unit in place. The station was put in service in February and will eventually house four 60,000-kw turbogenerators.



BOILER FEED PUMP

Each 60,000-kw generator at Bokaro is supplied with steam by two boilers and each pair of boilers has three water feed pumps. Two are in continuous operation and the third is a spare. One of the nine identical pumps in this service is shown here. It is an Ingersoll-Rand 8-stage unit with a rated capacity of 700 gpm against 1150 psi pressure. Its driver, at the left, is a General-Electric 700-hp totally enclosed water-cooled motor.

divided screens to keep out trash. Most of the river water used is required for the condensers in which the steam exhausted from the turbines is returned to its original state. All water discharged from the powerhouse flows into a tunnel that runs under the building for its full length and delivers it to a control structure 1200 feet away. From there it is diverted to the river normally at a point above the dam but below it during the dry season when it is recirculated after cooling by contact with the air. Water for drinking and for sanitary facilities is obtained from the village of Bokaro.

Water for raising steam is taken from the discharge tunnel and clarified and softened prior to use. The feed-water cycle is a closed one, and only enough water is added to compensate for evaporation and other losses. Condensate and make-up water is fed to the boilers by Ingersoll-Rand unit-type, rotor assembly 8-stage boiler-feed pumps, each of which has a capacity of 700 gpm against 1150 psig pressure and is driven by a General Electric 700-hp totally enclosed water-cooled induction motor. There are three pumps for the two boilers serving each generating unit—one for each boiler and a standby.

The station proper is 170x450 feet in ground dimensions and its main roof is 118 feet above the basement floor. It is constructed of steel and designed to sustain all normal loadings and to withstand wind forces and possible earthquake shocks. Four steel stacks—one for each pair of boilers in the ultimate 8-boiler installation—are self-supporting. The operating floor is of reinforced concrete and the upper platforms are removable metal gratings. A 15-ton gantry crane moves on a 360-foot outdoor runway with a 40-foot span. Conduits to handle the runoff from the torrential rains experienced seasonally range in diameter from 4 to 15 inches. The inner face of the station's east wall, 85 feet high and extending the full length of the structure, will be decorated with a series of murals depicting the history of the Bokaro region.

The site of the plant, which is about 200 miles northwest of Calcutta, was selected from among eight that had been examined by Indian geologists R. K. Sundaram and G. C. Chaterji. They had also tested stone from seven quarries for possible use as concrete aggregate and drilled at five points on the Konar River to determine the best location for the barrage to impound or divert the station's water supply. Thirty-six families in the construction area were displaced and allotted plots for homes in a new village provided for them.

The Bokaro Station was designed and constructed by The Kuljian Corporation, an American concern that does an international business and has built some 65 power plants on four continents. Plans were drawn in its home offices on Broad Street, Philadelphia, Pa., uniquely located in the former Widener brownstone mansion that was erected in an earlier era at a reputed cost of two million dollars. Construction was supervised from the firm's Calcutta office and by staff men on the job, with Hrand H. Levonian, Kuljian vice-president in charge of the project. Kuljian will operate the station for a year. At the end of that time Indian personnel will be familiar enough with it to take over. Eleven of the group came to America for training by Kuljian and General Electric Company.

FUTURE PLANT OPERATORS

Eleven graduate engineers were sent to the United States for ten months of instruction that would qualify them to operate the Bokaro power plant. They are shown here in The Kuljian Corporation's main office in Philadelphia with H. H. Levonian, Kuljian vice-president, who had charge of the planning and construction of the $35 million station. Left to right: O. P. Gupta, N. K. Chowdhury, Mr. Levonian, B. N. Banerjee, I. N. Das, S. P. Batra, M. W. Goklany, K. M. Chinnappa, S. K. Dass, V. I. Rao, S. K. Mukherjee, Bose Mullick.

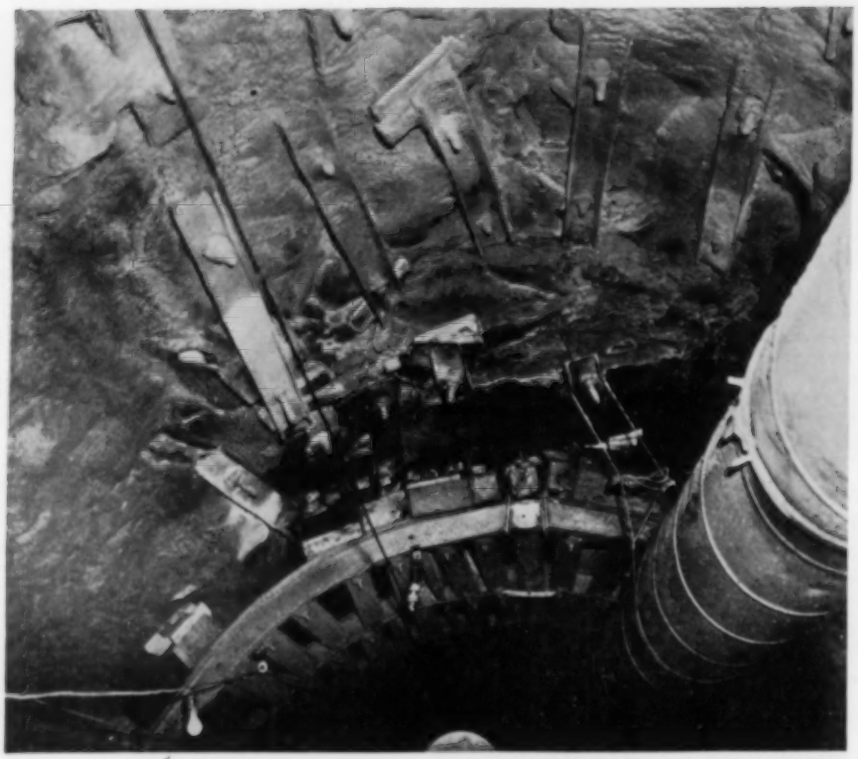
Pinning Up an Aqueduct Roof

Method Developed in Mining Industry is Employed Successfully in New York Water Tunnel

J. C. Pierce

LONG WAY TO WATER

New York City's cup is filled from tributaries of the Hudson and Delaware rivers via the Catskill and Delaware aqueduct systems. The East Delaware Tunnel discussed here is at the upper left and runs from Pepacton Reservoir to Rondout Reservoir, dropping 303 feet in the 25 miles. The average cover over the bore is 1060 feet. Vertical shafts were sunk at two intermediate points to facilitate tunnel driving.



ILLUSTRATIONS FROM U.S. BUREAU OF MINES

TWO TYPES OF SUPPORT

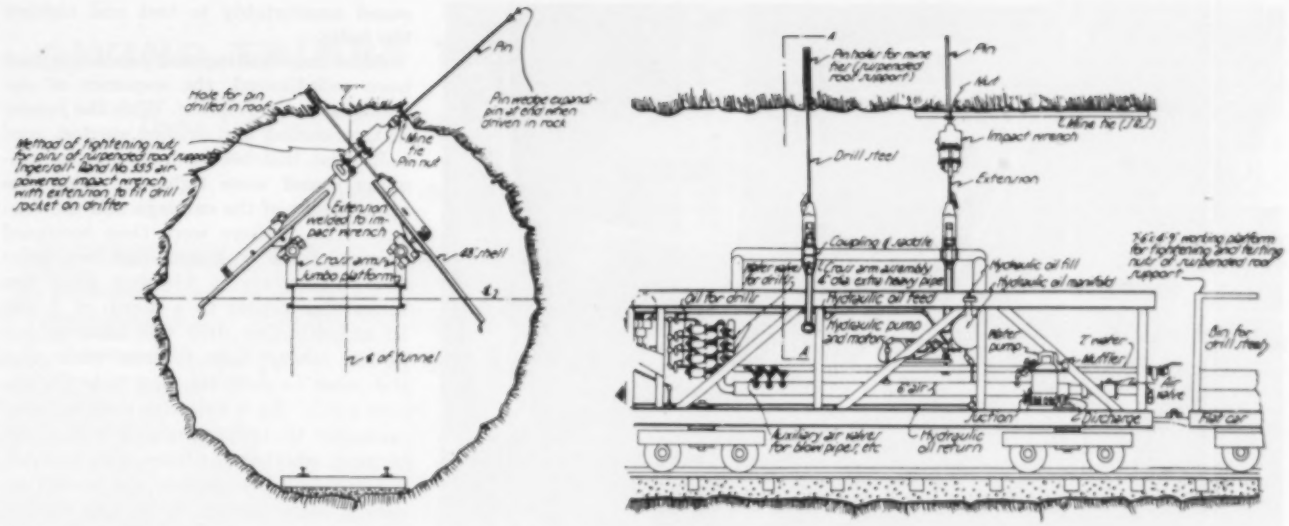
The farther tunnel section is supported by conventional steel sets and that in the foreground by steel channels each bolted to the roof in two places. The contrast in methods is marked, and it is easy to see that bolting saves time and money wherever conditions are favorable to its use. The roof-bolted area of the tunnel has been gunited.

ANY means used industrially to spare lives and to prevent crippling injuries should be of interest to us all. Now available are some significant results obtained with special bolts by which the roofs of mines and of other workings below ground are consolidated and made self-supporting. Whereas the mining industry was the first to apply the technique of roof bolting or "pinning" on a wide scale, it is today also serving to overcome dangerous conditions in other fields in the United States where men must venture underground for their livelihood. This article deals with an extensive experiment with suspension roof support in a tunnel and is based on a report, entitled *Roof Bolting the Delaware Aqueduct* (Information Circular 7652), prepared by D. H. Platt and published recently by the U. S. Bureau of Mines.

The experiments were conducted in the East Delaware Tunnel, which is located in relation to the entire aqueduct system in the accompanying map. That bore underruns some 25 miles of the Catskill Mountains between Pepacton and Rondout reservoirs in New York State and involves four contracts held jointly by Walsh Construction Company and B. Perini & Sons, Inc., under the authority of the City of New York Board of Water Supply.

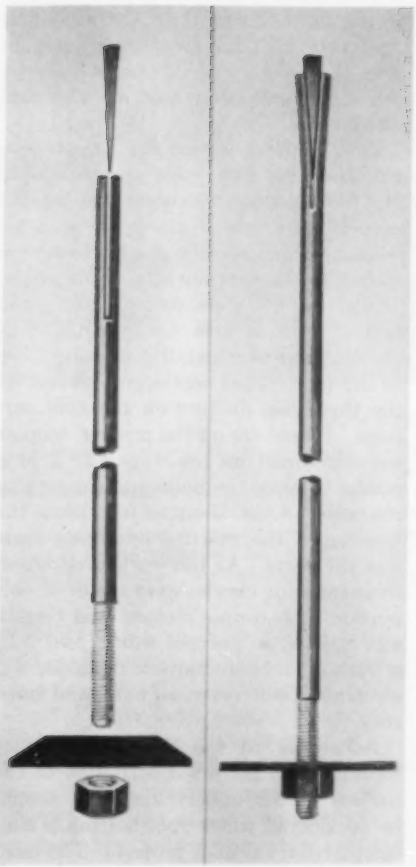
Roof falls are the No. 1 killer in the mining industry, but not one fatality nor one lost-time accident was attributable to that cause in the course of a year in the East Delaware Tunnel in which 124,350 pins were installed to support more than 65,000 linear feet of roof. One reason for the good record is that bolts can be applied much closer to the face than can steel sets, thus giving the workers protection most of the time they are underground. Furthermore, ventilation is better in areas where conventional steel supports are replaced by bolts, which are rarely disturbed by blasting close to the heading and are not dislodged or weakened by moving equipment. Unlike other retaining members, they do not have to be removed for pouring concrete linings and therefore obviate the hazards incident to working beneath unsupported roofs during form setting.

The economic advantages of roof bolting in the East Delaware Tunnel likewise proved to be manifold. It saved a large amount of vital steel that would otherwise have been needed, and it is estimated that for every foot of arch poured approximately ½ cubic yard less concrete will be required because of fewer voids due to the sloughing of rock over steel supports. Transportation of


Pin
Hole for pin drilled in rock
Pin wedge expands pin at end when driven in rock
Method of tightening nuts for pins of suspended roof supports. Ingersoll-Rand No. 555 air-powered impact wrench with extension to fit drill socket on drifter
Wire tie Pin nut
Extension welded to impact wrench
Crosh arm on Jumbo platform
48" shell
6' of tunnel
Pin hole for new tier (suspended roof support)
Nut
Drill steel
Impact wrench
Extension
Coupling & bottle
Hydraulic oil fill
Hydraulic oil manifold
Oil for drills
Hydraulic oil feed
Hydraulic pump and motor
Water pump
T water muffler
Air valve
Suction
Discharge
Hose air
Auxiliary air valve for blow pipes, etc.
Hydraulic oil return
Pan for drill steels

DRILL-CARRIAGE SETUP FOR ROOF BOLTING

The elevation sketch (right) and a section of it at A-A show how the bolting equipment was mounted on the jumbo that was used to advance the bore. One of the two drifter drills on a crossarm is putting in a bolt hole while the other holds an air-powered impact tool in nut-tightening position. The drills also served to drive the bolts to security in the holes and to hold the steel plates in place until they were pinned to the roof. The top three of six drifters (not shown here) at the front of the carriage were swung upward vertically to drill the holes for the suspension supports immediately back of the face.



ROOF BOLT

Shown is the split-rod-and-wedge type bolt or pin that was used in the East Delaware Tunnel and made in the contractor's shop.

conventional retaining structures to underground locations and storage places close to points of application is an expensive item. Not so with roof bolts and accessories, which are never bulky or of high unit weight. Increased clearance inside the bore through the absence of posts or columns makes for easier and speedier operations and better housekeeping in the working area. All this adds up to high over-all efficiency and lower cost.

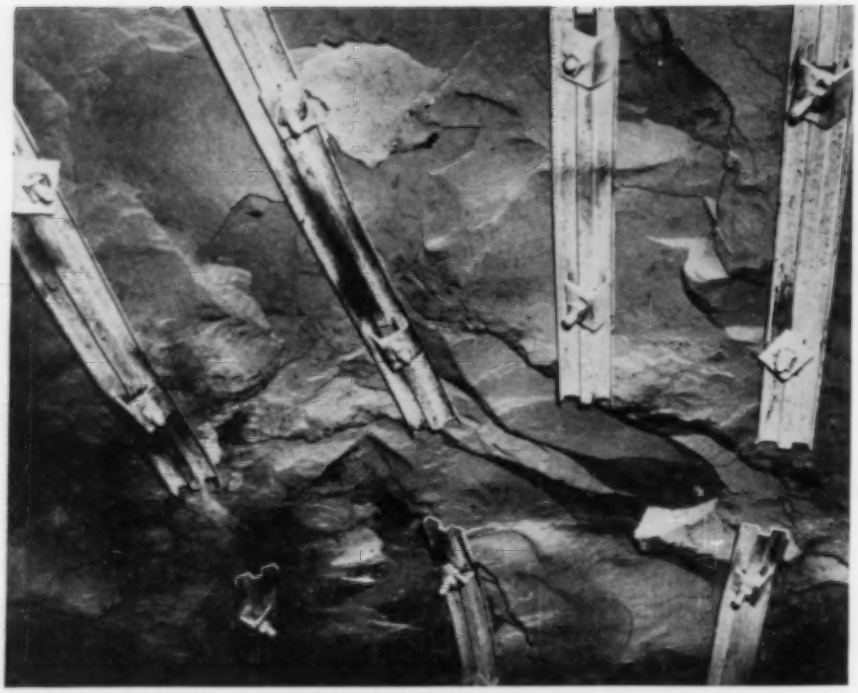
The vast Delaware Aqueduct System traces its beginning to a time early in this century when Greater New York had a population of four million and was expanding at the rate of about 115,000 annually. Realizing that large and dependable sources of water had to be provided to keep pace with this growth, the State Legislature created the Water Supply Commission in 1904-1905, empowering the City of New York to take care of its future water requirements. Not long thereafter the system was delivering water from the Catskills to the metropolis. According to the 1950 census there were 7.9 million people in the city (in 1947 consumption reached 1,160,000,000 gallons a day or about 147 gallons per capita), and with a population of 8.5 million persons expected by 1960, water resources must be continually augmented. The East Delaware Tunnel is the most recent project undertaken to increase the supply.

Roof bolting has not been generally accepted by underground men, and the officials responsible for the welfare of the workers and progress on the East Delaware Tunnel were justifiably cautious. There is some ground that cannot be supported by this means, and the Bureau of Mines warns against using the technique in rock structures of questionable character. During the summer of 1950 a few bolts with small bearing plates were tried in restricted, isolated areas. Although the results were not satisfactory, the authorities concerned were not oblivious to the merits of suspension roof support, and a thorough study was made of all available information on the subject. That was followed by a preliminary experimental program.

For the test, four sections of the bore were chosen as representative of the shale and sandstone formations encountered or apt to be encountered by the tunnelers. They vary in length from 226 to 449 feet and are located at points ranging from 2694 to 7053 feet in from the outlet portal. The supports decided upon were 9-foot steel railroad ties attached to the roof by two 6-foot-long slit-rod-and-wedge-type pins or bolts 1½ or 1¼ inches in diameter. Anchoring wedges were of the same width, 6 inches long and tapered from ⅜ inch to the thinness of a feather. Slots in the bolts to accommodate the wedges were 9 inches long.

In addition, approximately one hundred and fifty 6x¼-inch channel plates 4 feet long were each secured by one pin within 1500 feet of the tunnel portal. And at isolated points between the principal test sections were installed about 170 of the 9-foot steel ties, the bolts used being the same throughout. In all cases, the supporting members were placed roughly parallel to the direction of the 13½-foot-diameter bore.

Early in the research program the single-bolt plates were discontinued for 9-foot steel railroad ties installed in sets of four on approximately 30-inch centers. These bearing plates were 5½ inches wide and considerably strengthened by a deformed central section 1 inch deep. They were slotted about 10 inches from



CLOSE VIEW OF SUPPORTS

The pieces shown are standard steel railroad ties designed for mine and tunnel service. They answered the specifications for roof bolting in this instance and required only the cutting of a 4½x2-inch opening about 10 inches from each end. The angular washers made it possible to tighten nuts even though holes for the bolts had not been drilled perpendicular to the surface. The picture was taken before the roof was gunited.

each end for the bolts, and the distance between the ends of succeeding ties was about 3½ feet.

Drilling of the 5-foot 9-inch anchor holes was done with a power-feed drifter on a 6-foot column with crossbar and saddle. This assembly was mounted on the deck of a flatcar which was clamped to the rails when in service and permitted putting in the four holes radially across the roof. Upon completion of the drilling cycle each bolt was driven firmly in position by the drifter, using a drill rod tipped with a dolly that fit over the threaded end of the bolt. Another drill rod, equipped with a saddle shaped to fit the tie, was then inserted in the drifter to hold one end of the tie over the bolt until the 3x4-inch steel washer was inserted and the nut partly run. The flatcar was then moved under the opposite end of the tie, a hole was drilled through the slot, and the cycle of operations was repeated. Subsequently all nuts were tightened by a hand-held air-powered impact wrench. After a 50-100 foot section was completed in this manner, a layer of Gunite ¾-inch thick was applied.

By May, 1951, there was no longer any doubt about the advantages of roof bolting on this job, and recommendations by the Bureau of Mines to apply the method more extensively in the tunnel were approved by the New York Department of Labor and the City of New York Board of Water Supply. A new set of specifications was put into effect, and the contractor made plans to install the retaining members at the headings. Bolts of the same type and length were used, but they were 1 inch in diameter, the threaded end was 5 inches long and the slot 6 inches, or 1 and 3 inches shorter, respectively. Two kinds of supporting plates were specified: 6-inch channels 5 feet long and 9-foot steel ties.

Track-mounted jumbos carrying six drills were being used to advance the tunnel. For roof bolting, these carriages were provided with two horizontal crossarm assemblies which were welded to tubular uprights and arranged parallel to the long axis of the jumbos. The crossarms were about 18 inches above the upper deck and well behind the drills working at the face. Each was equipped with two drifters, and a flatcar pulled behind the carriage carried everything the crews needed for the work and had an upper deck on which the men could stand comfortably to test and tighten the bolts.

After roof bolting and tunneling had been coördinated, the sequence of operations was as follows: With the jumbo at the heading and drilling started, roof bolts that had been set during the previous round were tightened from the upper decks of the carriage and the flatcar. The drifters were then mounted on one of the crossarms and two holes were drilled about 5½ feet from the tunnel-line center to a depth of 5 feet 10 inches. One drill was used to put in the second hole for one plate and the other to drill the first hole for the next plate. Each hole was then sounded manually by tapping with a bolt to determine whether the formation was sufficiently solid to anchor the wedge securely when driven in by the drifter, as previously described. With the supporting members in place, the nuts were tightened with an air-powered impact wrench held by one of the drifters by aid of an extension that fit the drill chuck.

Both drifters were next elevated to drill the next two holes approximately 2½ feet nearer the center line of the tunnel, after which the cycle was repeated. Subsequently the drifters were shifted to the opposite side of the jumbo to put in two more sets of holes, and so on. But it was not possible with the crossarms to install roof bolts close to the face. That was accomplished by the three top drifters on the drill carriage. Elsewhere on the project, stopers were mounted on the upper deck of a jumbo to place the bolts and supporting channels or ties about a foot from the heading. Otherwise the operating cycle was the same. As the work progressed, frequent spot checks were made of bolt tension with torque meters, and Gunite was applied to prevent minor roof falls or slaking, a characteristic of shales and sandstones when exposed to air and moisture.

According to the Bureau of Mines report, many factors contributed to the success of the undertaking and should be considered where roof bolting is contemplated for similar projects. The most important of these are investigation of available data on the subject and of the problems involved before formulating specifications, and continual inspection and supervision of the work.

PROGRESS FROM MAY 8, 1951, TO MAY 20, 1952

	Roof Supported by Bolts Linear Feet	Number of Roof Bolts Installed	Roof Supported by Steel Sets, Linear Feet	Unsupported Roof Linear Feet	Total Advance Linear Feet
Inlet tunnel	5,108	10,158	12,964	7,233	25,305
Shaft 1, both headings	26,955	46,660	6,558	0	33,513
Shaft 2, both headings	21,220	46,584	6,738	0	27,958
Outlet tunnel	11,904	20,948	10,017	4,339	26,260
Total	65,187	124,350	36,277	11,572	113,036

GIVING THINGS THE SHAKES

There Are Places Where Some Jiggling Helps

Robert James

IN A FOUNDRY

Vibrators located on sand chutes leading from overhead storage bins (white arrow on Bin 17) assure free flow of the material. The valve on each vibrator is interconnected with the bin's release gate and goes on and off automatically as the gate opens and shuts. This prevents packing of the sand should the vibrator continue to operate when the gate is closed. Jolting machines of various types (lower right and left) are also used in foundries to consolidate sand around molds in forms. Most of them are air-powered.

HELPS IN PACKAGING

A vibratory table is frequently used for such work as putting pills in small bottles, filling cans with powdered materials and packing small parts, boxes or bottles in cartons. The table shown is provided with one of Cleveland Vibrator Company's standard vibrators which operate at frequencies of from 800 to 5000 per minute. The filter and airline oiler attached to the underframe are recommended equipment. From 4 to 40 cfm of air at around 80 psi pressure is required, depending on the size of the table.

EVER since man began to build machinery he has tried to eliminate vibration. That he has been successful to a large degree is shown, among other things, in the running characteristics of huge centrifugal pumps and blowers which operate smoothly and without vibration at very high speeds. Yet there are many cases today where it is a good thing to induce a bad case of the jiggles, and modern pneumatic vibrators are performing this task in ever-widening branches of industry.

The materials-handling field has taken over vibrators for its own—is utilizing them to break loose arches formed in bins and hoppers, to prevent clogging of chutes and pipes and to shake down granular material of different kinds in packaging it. In the founding industry they serve to pack the sand cores required to shape the interiors of castings, to remove unbaked cores from their molds and to free cores from finished castings. And the construction trade finds them very helpful in screening aggregates and in vibrating concrete to improve the appearance of the structures and to give them added strength.

The history and development of vibrators are interesting in scope, covering many fields and attempts to provide substitutes for equipment used but not designed for that purpose. Since man began to pour concrete in forms he has tapped their sides so that the material would flow into and fill all the voids. At first this was done to insure a better-looking product, and it was not realized until later that vibration also strengthens concrete by reducing honeycombing and saves money by permitting placement of a mix with a lower ratio of cement and water to aggregate.

Before pneumatic vibrators were available, foundrymen just naturally shook molds by hand to compact the sand, tapped their sides gently and repeatedly to remove cores, and shook the finished castings vigorously to loosen the sand. In mines and quarries, when chutes or hopper cars jammed for one reason or another, a broad-shouldered worker struck the sides with an 8-pound double jack, aiming the blows with a well-selected burst of profanity at the cussedness of inanimate things.

It is not known when mechanical vibration was first applied, because the man responsible probably did not grasp its significance. Records do indicate, however, that "tables for the vibration of sundry objects" were in service in England and continental Europe during the mid-1800's. They were described as spring-mounted platforms connected by a rod to a short-throw, high-speed crank and were used in foundries and in-plant concrete-casting rooms.

Until the 1870's, those tables were about the only mechanical vibrators in existence. Air-operated rock drills (at first steam-powered) were subsequently developed by Burleigh, Ingersoll, Sergeant and Rand, and with the widening application of those machines in mines and quarries and on construction jobs men noticed the natural tendency of the moving element to vibrate and began to take advantage of that characteristic.

OLD AND NEW CONCRETE VIBRATORS

At the right is shown an Ingersoll-Rand chipping hammer vibrating forms during concrete pouring operations at Shasta Dam. A plain-end steel was used and performed satisfactorily, though the tool was not recommended for the service. This type of "jury rig" was hard on the forms, but was used as recently as 1939. In the other picture, Ingersoll-Rand vibrators are compacting concrete on a recent bridge construction job. When vibrated internally, concrete flows like a liquid and fills the forms completely. Air rises to the surface and honeycombing is eliminated, resulting in a dense, wear-resistant mass that bonds well with reinforcing steel. These vibrators are made in two sizes which, with handles, weigh 23 and 45 pounds each. When supplied with air at 90 psi pressure they operate at frequencies of from 6000 to 9000 per minute.

With the advent of chipping hammers and other pneumatic tools, the practice of using them as vibrators spread. Even today many "jury rigs" made up of piston-operated air tools are serving in that capacity. However, they are not intended for that purpose, and the practice of letting them expend their energy upon their internal parts rather than in performing the work for which they were designed shortens their lives.

The first patent on a vibrator powered by compressed air was, according to information available, issued in Great Britain in 1890, and the equipment was used chiefly in foundries. At any rate, vibrators made their appearance in foundries before 1902, for at that time something occurred in England that was eventually to bring about improvements in methods of pouring concrete. In general, the consistency of the mix then placed was very stiff, and it was necessary laboriously to hand-tamp the material to prevent honeycombing. Indeed, it is said that the formula for good concrete in those days was the driest mixture of cement, aggregate and water that could be handled, and lots of "elbow grease."

At that time labor costs were low, but an engineer on a foundation job in a foundry considered elbow grease an expensive commodity and conceived the idea that vibrators might accomplish for the concrete industry what they were doing for the foundry. Consequently, units were attached experimentally to the "shutters" or forms to vibrate them and thus compact the concrete. The result was a product of such good quality that the project was completed in that manner. This might lead one to believe that concrete vibration was adopted immediately. However, it was soon discovered that the equipment suitable for foundry use would not stand up long under the more rigorous demands made on it in concrete work, and no other readily portable units were available.

After being shelved for fifteen years, save for a few minor instances, the vibratory method of compacting concrete was revived in 1917 by M. Freyssinet, a French engineer, who began to make a study of the strength, finish and durability of concrete treated in that way. So conclusively did he prove its advantages to himself, at least, that he saw to it that all the concrete entering into the construction of the parabolic hangars of Orly Aerodrome near Paris was vibrated after placement. And in this case, too, rock drills and chipping hammers were called into service, for, makeshift though they were, they were still the best vibrators available.

Before long, the method was put to use in other parts of the world, and by 1922 it had been applied in the United States on a scale sufficient to warrant engineering societies and materials associations to investigate and test concrete compacted by means of vibration. Their approval was soon translated into specifications and a more rapid development of equipment. Placement on small jobs was quite satisfactory, but on bigger ones, where vibrators were allowed to operate long enough to shake the material farthest away in the forms, it was determined that the concrete in the immediate vicinity of the units separated—the aggregate settled to the bottom and the lighter cement and water rose to the top. That led to machines for the pervibration—that is, internal vibration—of concrete, which won recognition during the mid-1930's. They were tried out among other places at Pickwick Dam of the TVA in 1934.

Typical of units of that type is one designed by Ingersoll-Rand Company. It consists of an eccentric weight driven by a Multi-Vane air motor and is enclosed in a hardened metal case. Each of the larger sizes is capable of compacting hourly upwards of 30 cubic yards

of concrete and can be easily handled by one man. The casing is circular and tipped with a modified truncated cone to permit insertion into tight corners and between webs of reinforcing.

Today, on most large undertakings including roads, concrete is pervibrated according to specifications, and with the advent of prestressed concrete beams the method is growing in importance. While it is not our purpose to discuss the technique of prestressing, it would be well to add a brief description of the two most used methods both of which depend upon the tensile strength of stressed steel cables embedded in the concrete. The first involves coating the cables prior to placing them in the forms with a material that prevents a close bond between them and the concrete. After the latter has been cast it is compacted and left to set. Then the cables are pulled taut, thus putting the whole member under tension. The second method is the same, except that the cables are not coated and are prestressed before concrete is poured around them. Both have their merits and advocates and give the beams great strength in tension as well as compression and provide very adaptable structural members. While prestressed concrete is being applied on a large scale mostly in Europe, it is gaining favor in the United States and is now being used on several big construction projects.

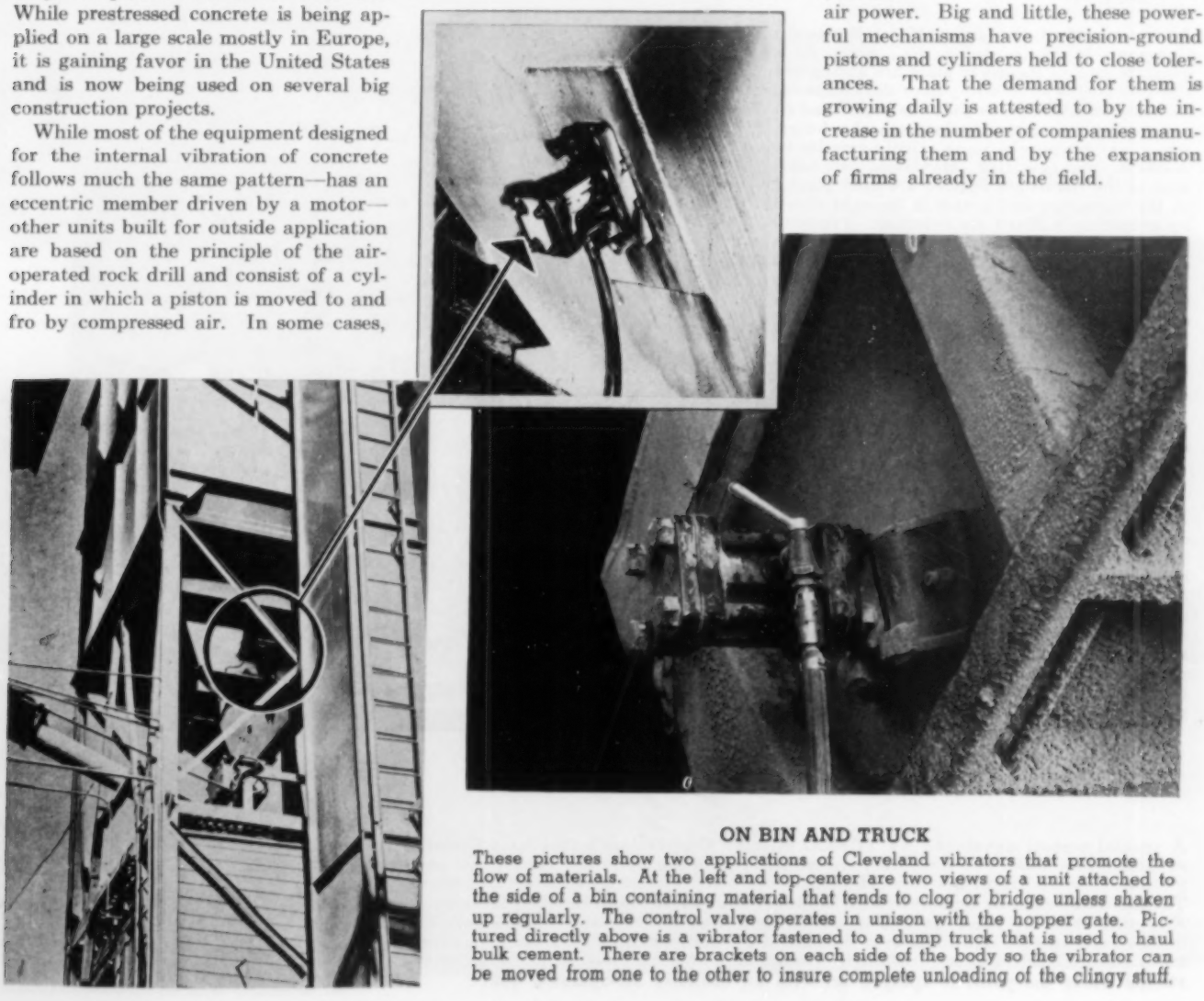
While most of the equipment designed for the internal vibration of concrete follows much the same pattern—has an eccentric member driven by a motor—other units built for outside application are based on the principle of the air-operated rock drill and consist of a cylinder in which a piston is moved to and fro by compressed air. In some cases, the air acts only on one end of the piston while a spring effects the return stroke. The frequency of the vibrations varies with the air pressure, which can be adjusted over a wide range by a control valve; the intensity of the impact is related to the mass of the piston and is generally fixed.

Fluidization of granular materials induced by vibration depends on nothing more than disturbing the frictional cohesion between particles and between particles and the side walls of the containers. Vibrators which eliminate bottlenecks in the materials-handling field are installed at points where bridges or arches are apt to form and are usually bolted to a heavy plate welded to the outer "skin" of the hopper or chute. Where service is intermittent, as in the case of hopper cars, dump trucks, etc., another type, typified by the RR Series manufactured by the Cleveland Vibrator Company, is used. It is provided with a number of Vee-shaped female brackets which are attached to the unit to be vibrated and into which are inserted wedge-shaped male plugs on the vibrator. By this arrangement the latter can be quickly shifted from one car to another as they are successively positioned for dumping.

In practically every industry there is a job that can be done well by a vibrator. For example, in a mill where nickel is produced, dust from a smelter is trapped on the rods of giant Cottrell precipitators and later removed by aid of units of the air-powered type. The dust collected each day contains literally hundreds of tons of valuable nickel and copper, which is thus salvaged and returned to production instead of being allowed to escape and pollute the atmosphere.

When it comes to packaging bulk materials and casting concrete blocks the vibratory table is indispensable, the only difference between the old and the new one being that the platform of the latter is jiggled by a little pneumatic vibrator that operates well-nigh noiselessly. In the category of novel applications, which are continually cropping up for all types, is the molding of chocolates on small vibratory tables and the harvesting of walnuts and pecans by attaching units to the trees.

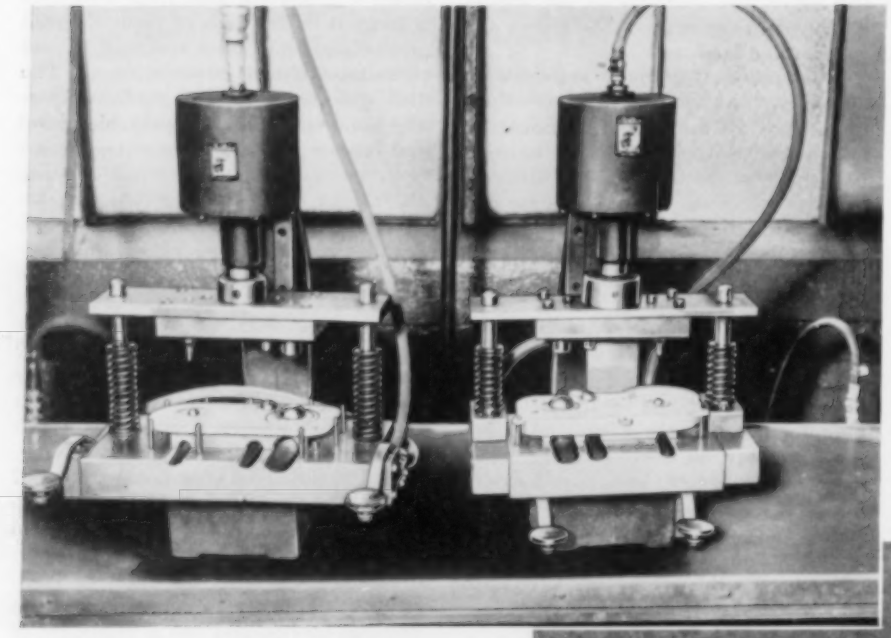
Modern vibrators are built of high-strength materials to give the longest possible service and use a minimum of air power. Big and little, these powerful mechanisms have precision-ground pistons and cylinders held to close tolerances. That the demand for them is growing daily is attested to by the increase in the number of companies manufacturing them and by the expansion of firms already in the field.



ON BIN AND TRUCK

These pictures show two applications of Cleveland vibrators that promote the flow of materials. At the left and top-center are two views of a unit attached to the side of a bin containing material that tends to clog or bridge unless shaken up regularly. The control valve operates in unison with the hopper gate. Pictured directly above is a vibrator fastened to a dump truck that is used to haul bulk cement. There are brackets on each side of the body so the vibrator can be moved from one to the other to insure complete unloading of the clingy stuff.

COMPRESSED AIR AT WORK



At the plant of the Atlas Metal Stamping Company in Philadelphia, Pa., holes in a gearbox and in its cover plate are accurately sized by means of the equipment shown above. In each case, the work piece is registered in a jig, with open spaces beneath the holes, which are purposely made a little smaller in diameter than specified. Hardened ball bearings of the diameters desired are then placed in the openings and a ram is brought down by actuating a Mead air cylinder. Properly positioned pins force the balls through the holes, thus giving them their true diameters. The balls drop into slots, from which they are recovered for reuse. Two hands are required to operate the cylinder control valves, thus saving fingers from possible injury.

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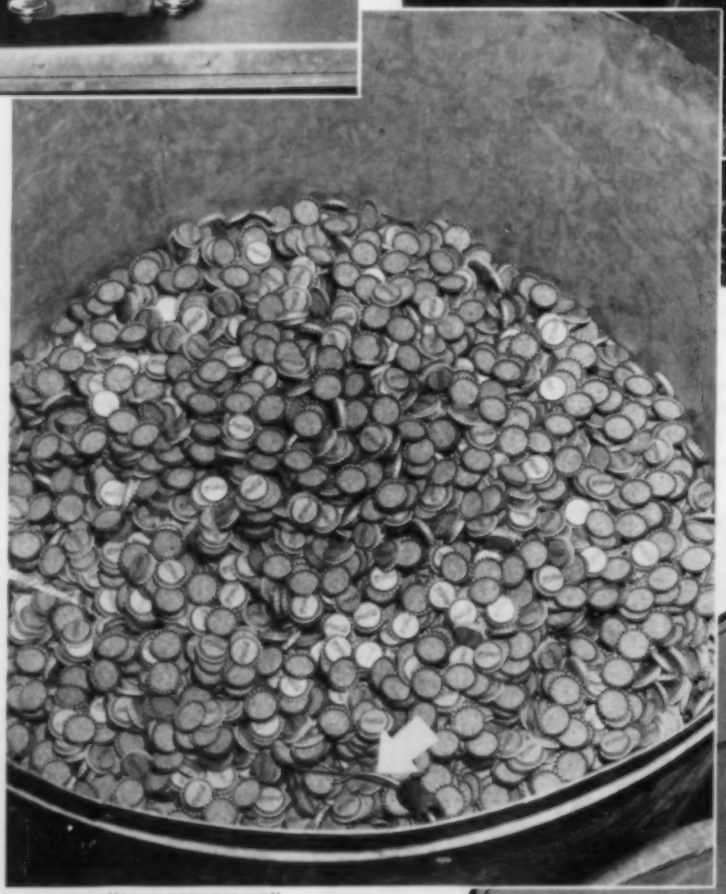

A day's supply of metal and cork crowns or caps for the Coca Cola bottling plant at Waukegan, Ill., is shown at the right. From the hopper, which has a tight-fitting cover on it when in service, the caps are fed to a hopper whence they drop into crowning heads on the bottling machine. Barely discernible at the bottom-center (see arrow) is a small pipe through which compressed air is blown to expedite movement of the crowns and to prevent "hangups" at the discharge opening.

PHOTO FROM "PACKAGING PARADE"

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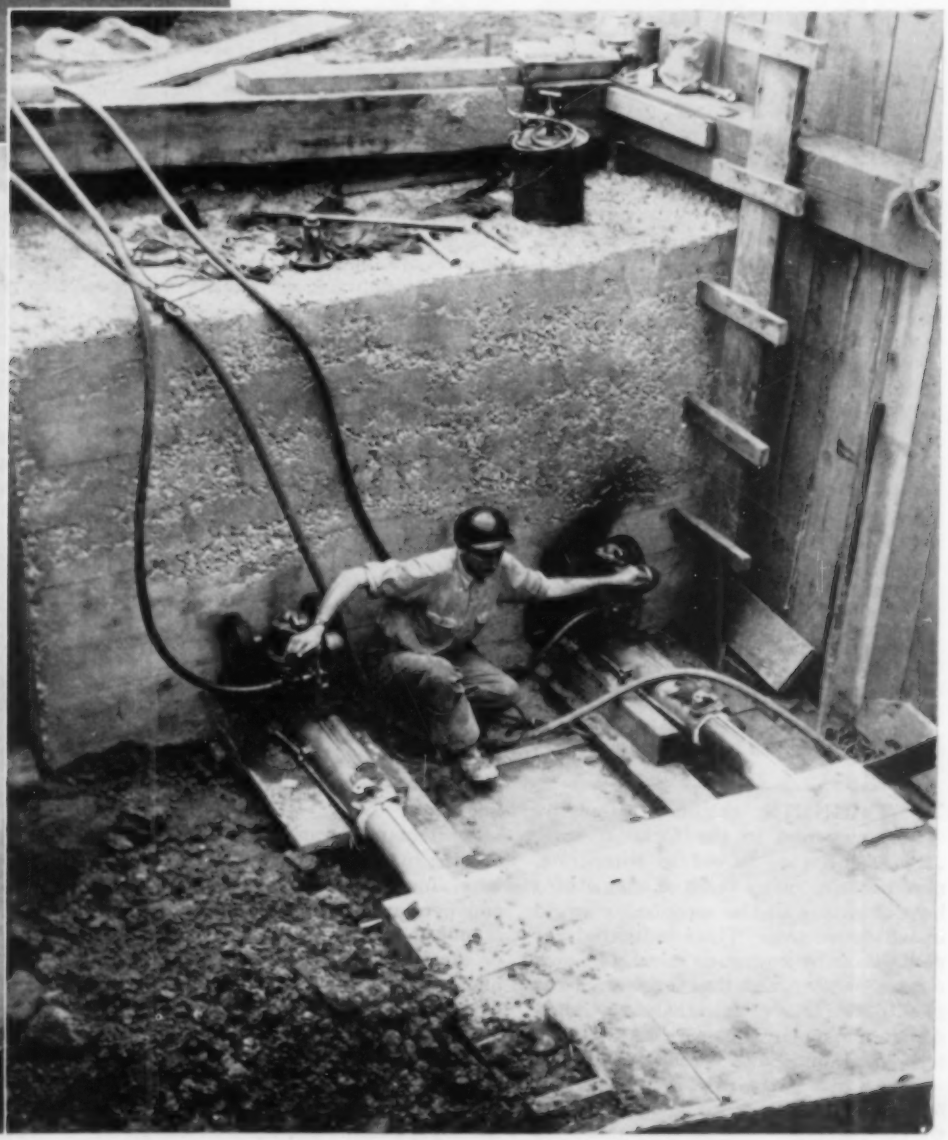
A special stencil developed by TEMCO Aircraft Corporation's Overhaul Division at Greenville, Tex., has simplified the work of painting dials for Type B-16 compasses. The dial is in the form of a truncated cone with degree marks all around. The markings must be accurate, as the slightest error could result in faulty navigation. Applying them by hand, as was formerly done, was difficult and expensive. The hollow cone stencil, right, fits over the face of the dial, which is mounted on a swivel base. Stencil and dial are rotated by means of a knurled knob at the apex of the stencil while the paint is sprayed on with an ordinary air-operated gun.

The Lamb Air-Mover shown at the left is used by the Lone Star Gas Company to exhaust explosive vapors from tank cars so workmen can enter them safely. Compressed air introduced by way of the hose connected at the left end of the mover, which is attached to the car's discharge pipe, blows through the exhaust unit and thus draws atmospheric air into and through the car by aspiration. The air enters the dome at the top of the car and is directed towards both ends by a deflector developed by the company. The picture shows an inspector holding an explosimeter at the discharge end of the Air-Mover to test for hydrocarbon vapors. This method has reduced the time required to purge an 8000-gallon car from 16 hours to one hour.

PHOTO FROM "OIL & GAS JOURNAL"



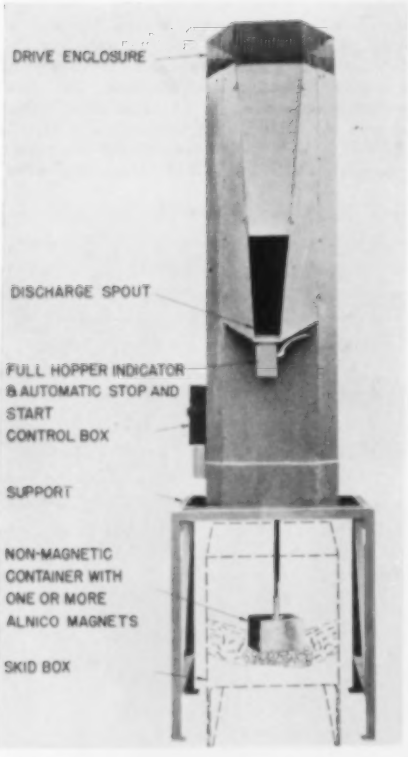
Two Joyce 100-ton air-powered screw jacks resting against a 10-cubic-yard block of concrete are shown below pushing an oak frame of 12x12-inch timbers which, in turn, is bearing against a section of 60-inch reinforced-concrete pipe. In this manner, and by adding successive lengths of pipe after each push, a drainage conduit was forced 82 feet through a railroad embankment at Fanwood, N.J., at a level 19 feet below the rails. The work was done by Angelo Fastiggi & Son, Inc., of Cedar Grove, N.J.

PHOTO FROM "CONSTRUCTION METHODS"

Doing Things with Magnets

Describing Some of the Many Services They Perform in Shop and Home

Robert J. Nemmers


DRIVE ENCLOSURE
DISCHARGE SPOUT
FULL HOPPER INDICATOR & AUTOMATIC STOP AND START CONTROL BOX
SUPPORT
NON-MAGNETIC CONTAINER WITH ONE OR MORE ALNICO MAGNETS
SKID BOX

MAGNETIC ELEVATOR

A Magnavator, which elevates nuts, screws, rivets or other small ferrous pieces to storage bins, hoppers of machine tools, or elsewhere. After a magnet with its load has been raised inside the housing by a moving chain and positioned over a discharge spout it is partially withdrawn from the nonmagnetic container, thus weakening the magnetic bond and letting the load fall.

MAGNETS, originally used by sorcerers in the form of lodestones as an aid to witchcraft, now perform many feats of magic of a helpful nature in the astonishing world in which we live. Their industrial application is by no means novel, but now a relative newcomer that possesses great possibilities is coming to the fore. Called Alnico magnet by reason of its composition—aluminum, nickel, cobalt and iron—it is a true permanent magnet as differentiated from the electromagnet and the steel magnet. The electromagnet has a surrounding field of force only so long as current flows through its coils; the iron or steel magnet tends to lose its magnetic properties in time, especially when subjected to heavy jolts or jars.

Leader in putting permanent magnets to work is the Carboloy Division of General Electric Company, which did much of the initial work that led to the development of the type. Its services have become numerous, and among those listed by the organization are some that are improvements of common practices and others of a new and unusual nature. For instance, when rearranging plant machinery or planning new factory facilities, it is possible by means of small Alnicos to hold models or templates of the equipment to be installed to a scale layout of the floor. That permits moving them around until the best arrangement is worked out, thus ofttimes obviating shifting heavy machinery and the expense involved. Such a plan can even be carried from place to place because ordinary jarring will not dislocate the magnets.

As a manufacturing aid, Alnicos are serving manifold purposes. In one factory, for example, an overhead tram conveyor with magnets attached is the standard system for relaying small iron or steel parts of a wide variety from one assembly-line operation to another. The pieces are easily attached by bringing them in contact with the magnets, and are just as easily removed. Prab Conveyors, Inc., has designed another type for transporting small parts. Called the Magnavator, this carrier feeds pieces to elevated machines or storage hoppers, transfers them from one conveying system to another and does many other lifting and moving operations. The unit is equipped with an automatic device that stops the mechanism whenever the hopper it is loading is full and starts it again when the hopper contents drop to a predetermined level.

The handling of stacked steel sheets, which are difficult to pick up by hand, is facilitated by an arrangement of permanent magnets that separates and lifts the top sheet from the pile. This not

MOWING AN ASPHALT "LAWN"

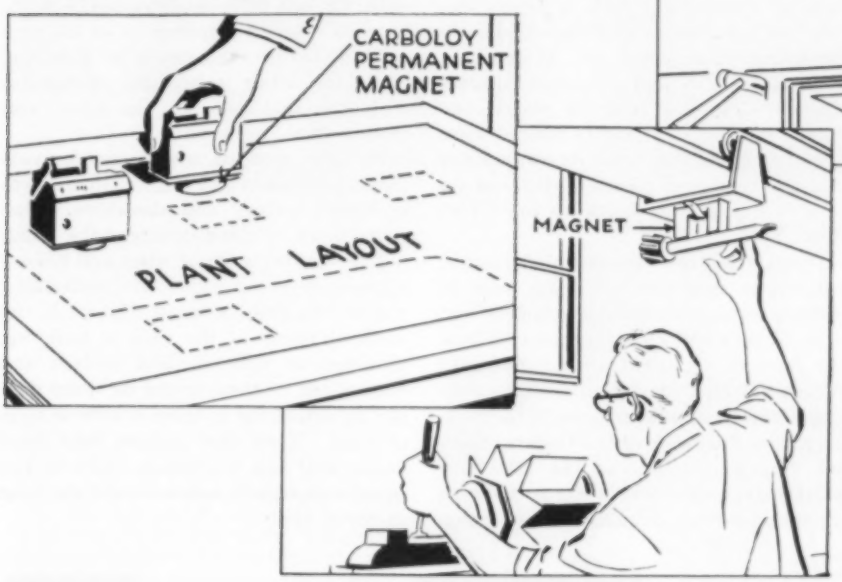
This Super Sweeper built by Eriez Manufacturing Company, Erie, Pa., removes nails, tacks and miscellaneous ferrous materials from areas such as the shopping-center parking lot pictured. Looking much like a lawnmower, the magnetic device functions well at speeds up to 10 miles an hour. A smaller machine of similar design picks up ferrous chips, filings and the like in industrial shops. Nonferrous metals, paper, etc., are left, thus effecting separation.

MAGNET FOR THE EYE

The Eye Sweep is a handy addition to the first-aid kit. It has a magnetic tip on one end for removing minute ferrous particles and a flexible loop on the other end for dislodging cinders, grit, etc. Sterilization of the instrument has no effect on its magnetic properties. General Scientific Equipment Company is the manufacturer.

PRACTICAL IDEAS

Here are a few suggestions from the Carboloy Division of General Electric Company as to how industrial plants can put Alnico magnets to use. At the right is a simple, convenient and durable tool rack that may be of any desired length. Unseen is a series of magnets whose poles are connected by strips of soft iron at the top and bottom and whose midsections are covered with wood. The sketch directly below shows how magnets can be utilized in layout work by fastening them to the undersides of templates or models of machines so the latter adhere to a metallic base plate but can be readily removed. A simple I-beam conveyor for transporting metal parts is pictured at the bottom. The use of magnets eliminates the need of hooks or baskets.



only protects the worker's hands and fingers but also prevents feeding "doubles." The Magnetool Division of Multifinish Manufacturing Company has developed a bar with sliding magnetic heads that is of great aid in feeding ferrous parts into a press and removing finished work. It will handle sheet stock, formed pieces and castings.

Other magnetic devices that play an important part today in materials handling extract tramp iron from freely flowing substances. One consists of a hopper type housing a group of circular steel disks on 1-inch centers that serve both as pole pieces for magnets mounted in the intervening spaces and to distribute the magnetic field. The unit is made by Eriez Manufacturing Company, which has also designed a grate magnet for the same purpose. In this case, powerful Alnicos are set in a series of stainless-steel tubes against which the material is directed by a steel grill or baffle. In addition, there is a vertical down-pressure trap for use in slurry lines. The latter is placed in a vertical plane to take advantage of the force of gravity, thus permitting the material to fall directly onto the face of the magnet. The device protects pumps and refiners from metallic contaminants, and, like the others, can be blown clean with compressed air when it has picked up a load.

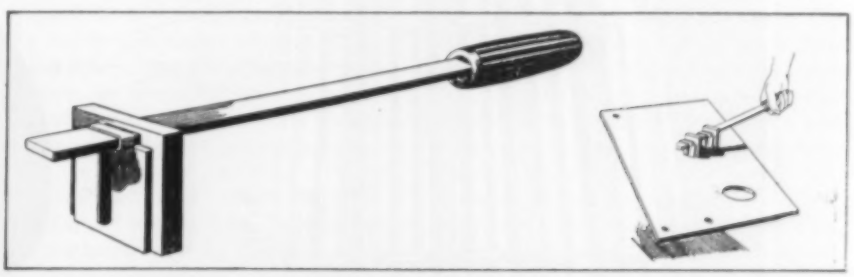
Then there is a magnetic clean-out tool for tanks in which paints and finishes and hydraulic oils are stored. A product of Standard Portable Cord Company Inc., it serves to remove tramp iron from the fluids. Magnetic plugs for insertion in the crankcases of automobile engines have become popular because they pick up and hold bits of iron and thus prevent them from being recirculated and possibly scratching or pitting finely ground surfaces. The plug is cleaned when the oil is changed.

Vises with magnetic jaws have been introduced by the Magne-Grip Tool Company. The jaws are said to cling tight to the vise and securely to lock and hold the work, regardless of its shape, in a 2-way "V" groove. The magnets used for this purpose are made of an alloy that will not mar delicate finishes and will retain its magnetic properties for a long period. Major advantages of the jaws are the ease with which they can be attached and detached and the fact that they can be remachined should they become mismatched or get out of line.

Removable lamps and safety shields for machine tools have been made more adaptable by means of Alnico magnets. Mounted on small but powerful magnetic bases, they can be "stuck" on wherever they will best illuminate the work or guard the operator against flying chips. And just a pull will free them if it is desired to shift them to another position.

One of the biggest consumers of permanent magnets is the radio and television industry. The loudspeaker of every receiving set contains a magnet, and it is estimated that 6½ million TV sets and nine million radio sets will be built this year. Magnets of this type also enter importantly into various electronic devices for military purposes. For that reason their two relatively scarce components—cobalt and nickel—are allocated to magnet makers by the National Production Authority.

All told, about 80 percent of the cobalt we consume goes into military end products, particularly jet aircraft engines, and its use for general purposes is consequently subject to control. Because



MAGNETIC LIFTER

Made by Multifinish Manufacturing Company, Detroit, Mich., this bar can be fitted with one or more permanent magnet heads, as shown, for lifting ferrous parts. It is useful for feeding presses and removing the finished work.

manufacturers of magnets can't survive on defense business alone, efforts are being made to spread the stocks of both cobalt and nickel by instituting conservation measures.

Permanent magnets are playing a big role in the field of dynamic testing in which oscillographs with accessory galvanometers using magnets make records of as many as eighteen different dynamic and static conditions. Modern technology requires that tests of this nature be made of prototypes of machines before they go into production in order to determine if they will function as they should when put in service.

A magnetic fishing tool for oil-well drillers fills a long-time need for a rig that can retrieve pieces of iron or steel from the bottom of a hole. Earlier attempts to design an effective device of this kind failed because there was no magnet of reasonable size available that was strong enough to carry a big load, that was shaped to permit the flow of the circulating fluid or "mud" in the hole, and that could be easily rotated to help dislodge junk embedded in the side walls and bottom. The Alnico meets all these requirements and makes it possible to control the force field and to concentrate it around the base of the fishing tool. In addition, it is sufficiently resistant to wear so that running it into the hole does not damage it. Tools of this kind are manufactured by K & G Oil Tool & Service, Inc. It is claimed that the largest size will lift a 1-ton load.

In a similar manner, a small magnet that can be readily attached to the end of a drill rod is used to retrieve steel Jackbits, tungsten-carbide inserts of Carset type bits and even pieces of drill rod lost in blast holes put down with conventional rock drills. Although tungsten carbide is magnetically weak, the magnet is strong enough to pick it up in most instances. Such a fishing device has been made by Dings Magnetic Separator Company, of Milwaukee, Wis., since 1948, and Canadian General Electric Company recently placed one on the market. The Dings magnet can, it is claimed, lift 40 times its own weight and has recovered pieces of drill rod up to 6 feet long from holes up to 14 feet deep.

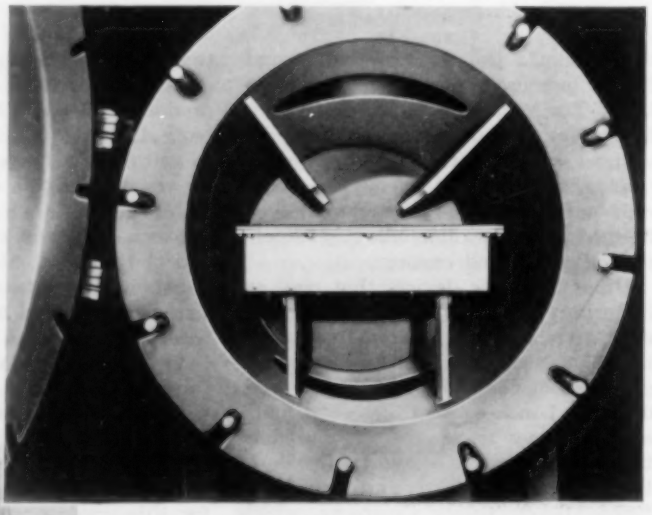
Outside of these industrial demands, permanent magnets are being used to extract ferrous slivers from fingers and eyes. A tack was recently removed from the lung of a patient with a powerful Alnico attached to a probe. The individual faced complicated respiratory surgery until engineers of the General Electric Company fashioned the little surgical instrument. But perhaps the most ingenious service devised for these magnets is in the field of dentistry. We are informed that dentures can be made to fit tight by tiny yet powerful permanent magnets compounded of platinum and cobalt. They are embedded in the jaw bones by oral surgery and act against others built into the plates.

Even the toymaker has found applications for Alnico magnets. He is incorporating them, for example, in small plastic dogs which are sold in pairs and attract or repel each other, depending on the polar arrangement of the magnets. Or, one little creature can be made to walk around apparently of its own volition on a table with a thin top while the other is brought in contact with the underside of the table and moved about by hand.

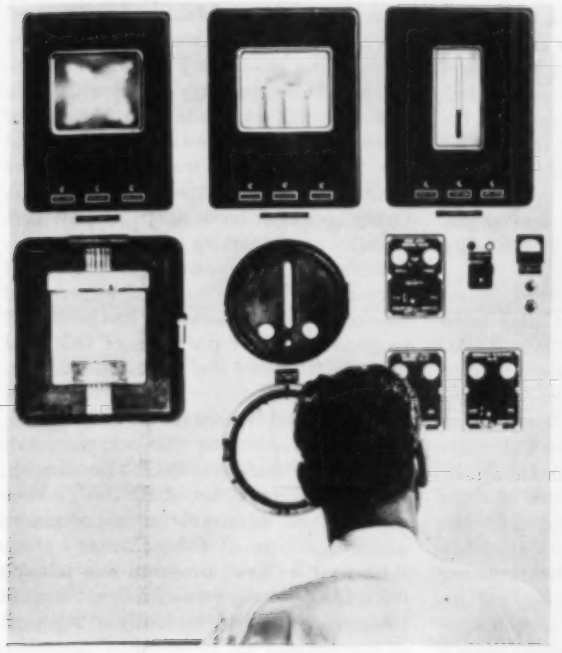
As time goes on, many uses for permanent magnets will suggest themselves in home, factory and elsewhere. One that comes to mind concerns the hanging of pictures without wires and nails—without defacing walls. By embedding one or two rows of small Alnicos in the walls of rooms at the time of building, pictures, as well as light shelves and even plant holders, could be hung simply by attaching to them a narrow strip of steel. Then that picture that Aunt Jenny sent last Christmas could be put up at a moment's notice should she drop in for a visit.

APPLICATIONS BY ERIEZ

Illustrated are three pieces of equipment that are designed to extract tramp iron from free-flowing materials. At the right is a trap for use in vertical pipe lines. Inside the cylinder, which has top and bottom openings, is a horizontal magnet face plate over which the fluid passes. Ferrous particles in it are caught there and can be removed periodically by sliding the plate out through a pressure-sealed side door. The device is made in sizes to handle from 1500 to 5000 gpm. It was designed primarily for service in paper mills, but can be utilized elsewhere. A grate separator is shown below. There are magnets within the 1-inch tubes against which the flowing material is directed by baffles between them. Ferrous accumulations on the tubes may be wiped off or blown off with compressed air. The assembly of steel disks pictured at the lower right is placed in the inlet of a hopper. Entering material passes between the disks where magnets attract and hold tramp iron.

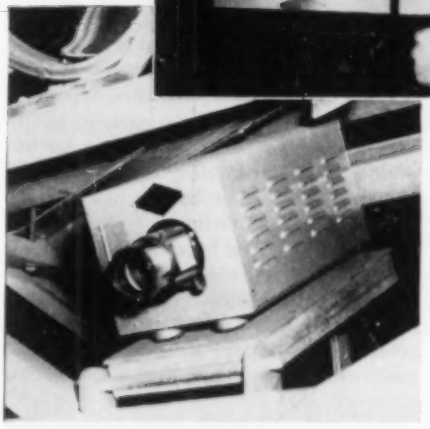


Electronic Eyes for Industry



SEEING THROUGH WALLS

The man seated in front of a powerhouse control panel is watching the behavior of the steam generating system on the three screens at the top. The one at the left shows him the flame activity in the boiler firebox; the center one, how much smoke is issuing from the stacks; and at the right he has a continual view of the boiler water-level gauge.



STEEL-MILL SENTINELS

At the Columbia-Geneva plant of United States Steel Corporation, in Geneva, Utah, electronic eyes watch the process of heating slabs for rolling. The operator in his booth sits where he can observe one furnace. He can't see two others, but each one has two TV cameras trained on it. Two of the four monitors are shown in front of him; the others are out of range. At the left is one of the cameras, which is mounted amid floodlights that illuminate the furnace opening. This Diamond Power Specialty Company Utiliscope setup replaces human observers and their hand signals.

"WHAT have you gentlemen done with my child? He was conceived as a potent instrumentality for culture, fine music, the uplifting of American intelligence. You have debased this child. You have made him a laughing stock to the intelligence." This remark was phrased by Lee De Forest, inventor of the vacuum tube which led to the development of what he terms his child—radio. The same remark could easily have been made by the men who invented television. Generally, they have been dismayed that entertainment has overshadowed the technical use for which they conceived it. Today, however, TV is invading many branches of industry and education.

The originator and leader in the field of industrial television is the Diamond Power Specialty Corporation which first applied video in central power stations and developed a complete line of viewers, cameras and power units. Lens arrangements are now available for fixed-focus viewing, for remotely controlled variable-focus viewing, and for mounting on remotely controlled variable-focus turrets. The latter are especially valuable where an over-all picture of an operation is needed together with a close-up of a particular part of that operation.

Applications of the electronic eye differ widely, but its most important industrial user is still the central power station where TV transmits the images of boiler gauges to a screen in the main control room, thus eliminating long line-of-sight ducts and complicated mirror arrangements; shows whether all the torches are burning when "lighting off," that is, igniting either the pulverized coal or fuel oil used to raise steam; reveals conditions within boilers—flame activity; or, focused on the smokestack, indicates at a glance whether an excessive amount of smoke is being produced. It might be of interest to mention that in a recent installation both the camera and the lens, the latter protected by a window, are air-cooled and pressurized.

In steel plants there are sets by which control of such varied jobs as continuous billet pouring, slab spotting on rolling mills and loading of cooling furnaces is assigned to one man, thus dispensing with the helper who, by the former method, was required to signal him by hand and was thereby sometimes exposed to danger. Use of the television chain when pouring large castings in foundries insures a safe, cool station from which to view the work. In government arsenals and laboratories TV provides the eyes to watch hazardous operations such as machining solid high explosives, testing materials and parts to destruction and defusing bombs. There are other applications along this line in atomic energy research plants where intensely "hot" reactions may be observed without dangerous exposure to radiations.

Two Hawaiian sugar plantations—the Ewa Plantation Company and the Waialua Agricultural Company—are being equipped with television systems so that operators in the mills may have a continual view of the cane as it moves from the cleaning plants to the grinders. This is essential, because efficient mill operation depends on an even, steady flow, and the cameras, mounted over the conveyors and shielded from dust and spray, will enable controllers to maintain the desired rate of feed. Here is another instance where TV is the solution of a problem the owners had tried to answer

with an arrangement of mirrors which failed because vibration blurred the view transmitted.

Television can likewise be of help in business offices. At the New York Savings Bank in New York City there is a camera in the centralized accounting room. When a customer wants to withdraw money, the teller, without leaving his post, can quickly check the depositor's balance by phoning his account number to an accounting-department attendant. The latter withdraws the corresponding card from the file and holds it before the camera, thus enabling the teller to see its image on a screen in front of him. By the previous procedure, tellers' windows were marked alphabetically and all the files had to be kept nearby and consulted each time a teller had to know how much money a customer had in the bank.

Industrial TV is generally much less complicated than television as we know it in our homes. In the case of the former, the transmitter or camera relays the picture message a comparatively short distance through directly connected coaxial cable, and the receiver or viewer does not have to define the image with the clarity we demand in our entertainment sets. Nor does either camera or receiver need as much power. However, the industrial hook-up must meet certain requirements that home sets would never be called upon to fill. It must, for example, be far more durable —be capable of operating 24 hours a day, day in and out, under a wide range of temperature variations and of withstanding vibrations caused by heavy machinery, something that would remove a commercial set from service in a short time. And so far as cost is concerned, it can be a real money saver because a basic chain, consisting of a viewer, camera and power pack, is available for about the pay of one skilled laborer for a year. If, as in the case of the steel-plant operations mentioned, a unit takes the place of one man on three shifts, the economies thus effected are readily apparent.

Radio Corporation of America, Remington Rand and Du Mont also have gone into the business of industrial television, and, though late, are entering some of the same fields covered by Diamond Power. In addition, Remington Rand, in conjunction with the Columbia Broadcasting Company, and Du Mont are doing notable pioneer work in color television. Remington Rand uses the CBS color system, while Du Mont has its own. Most of these applications are in the department of education and instruction. Since 1949 the pharmaceutical house of Smith, Kline, & French has demonstrated the CBS color system at many medical conventions. Color TV has made history by giving hundreds of physicians the chance to watch famous surgeons perform complex operations. And because the camera has a better vantage point than even an individual doctor standing right alongside a surgeon they often have a better view of the entire procedure.

Television of the type normally found in our homes has also invaded industry, mostly in the public-relations and sales fields. A recent instance of this kind occurred on January 12 when 1000 automotive engineers, assembled in the Rackham Educational Memorial, witnessed an exclusive closed-circuit telecast of new axle-testing machinery at the Timken-Detroit Axle Company in Detroit, Mich. The showing was under the auspices of the Society of Automotive Engineers and the test equipment was located in the company's laboratories 5 miles away. Other concerns have adopted television for sales presentations—broadcasting exhibitions of new products over a closed network to large groups of buyers and salesmen. Color telecasting has been used to good effect for purposes of this kind because it shows the wares to best advantage.

The United States is not alone in applying television to the advancement of learning and science. The British, through the facilities of BBC-TV, have televised an admirable series of shows under the title of *Other People's Jobs*. Last year a "live" program was relayed from the working face of a Scottish coal mine to viewers in virtually every part of the island. Of 35 minutes' duration, it was sent from a temporary rigging at the Tillicoultry Mine via microwaves to the Kirk o'Shotts transmitter and thence over the network. By careful planning and arrangement of shifts, it was possible to show a complete mining cycle, including the firing of a shot. The working face of the drift televised was approximately 2400 feet below the surface.

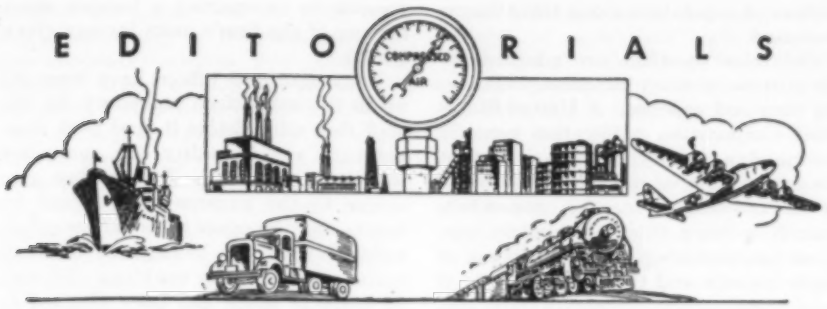
At London airports, cameras are checking on alighting planes and those aloft. This is not yet being done in America, though some of our railroads are using TV setups to guide them in switching incoming and outgoing trains.

When the British submarine *Affray* was lost with 75 men aboard, a TV camera saved the salvors valuable time. Lowered in a watertight compartment, it "observed" the sunken craft through a window with such clarity that its name could be read on a screen in the cabin of the surface rescue ship. When moved to various vantage points, it viewed the foundered vessel from all angles and permitted those abovewater to map out a plan of raising it without resorting to the usual time-consuming practice of sending divers down.

Various prophecies have been made concerning the future of TV both in commerce and industry. It has been suggested that the electronic eye might, possibly, operate mining machinery in dangerous areas by remote control and thus obviate the need of miners. That would involve the use of infrared light in the dark workings. A similar hookup might be of service in directing construction jobs. It is expected that television will become more and more useful to industry as time goes by and that it will take the place of our own eyes in many instances where our actual presence would be not only unsafe but impossible.

CAR-LOADING AID

By means of the levers and buttons shown at the left, Elwyn Shettler, Ford Motor Company employee at Buffalo, N. Y., operates an automatic metal scrap baler and also a conveyor that delivers the bundles to freight cars outside the plant. On the TV screen in front of him he sees the bales tumble into cars and is thus able to control loading.



THE QUEST FOR MINERALS

MINERALS are growing more important in our economy all the while, yet year by year we are mining a continually diminishing share of those we consume. Our peacetime prosperity is based on metals, and in times of national emergency we have imperative need of them.

The familiar old standbys—iron, copper, lead and zinc—are still indispensable, and the demand for them mounts steadily. But they can no longer carry the load alone. During the past 50 years they have been joined by a newcomer—aluminum. Once rare and costly, its annual output is now measured in the hundreds of thousands of tons. Although much scarcer, nickel is also being graduated from the ranks of the less known metals. The man in the street likewise has a nodding acquaintance with manganese, tungsten and molybdenum, and he has heard of a host of others.

One that he reads about often is titanium, which has a promising future. Right now it is at the stage where aluminum was half a century ago: useful but in small supply and expensive. But there's lots of it in the ground, and metallurgists are bound to bring its cost down within reach of potential industrial users. In the news, also, are magnesium, and rare metals and earths such as germanium, zirconium, cerium, lithium and others. And then, of course, there is uranium, which has captured the public's imagination.

Although we are ostensibly a declining mining nation so far as our domestic output is concerned, some of our larger operating companies have gradually extended their activities into many sections of the globe. It goes without saying that they will continue to expand these foreign developments at every opportunity.

The demand for minerals ebbs and flows with changes in our economy, but over the long range the curve moves steadily upward. And as there is every reason to believe that this rising trend will continue, our mining companies are setting their sights far ahead and endeavoring to insure the nation an adequate future supply of all the essential materials that come from the ground. They can do this only through systematic exploration, and planning towards this end is currently occupying much of their attention.

Indicative of the quickened search is the recent action of Kennecott Copper Corporation in setting up a new department of exploration headed by Dr. James Boyd, former director of the U. S. Bureau of Mines. Under his leadership, geologists, geophysicists, geochemists and other specialists will comb expansive sections in many countries. Doctor Boyd discussed these plans briefly in a recent talk at Lafayette College and expressed the opinion that the key technologist in modern prospecting is still the geologist. The others he characterized as the geologist's tools.

Doctor Boyd dropped a hint that one of the principal hunting grounds of his corps of ore seekers will be the Appalachian strip that runs virtually the length of the eastern side of the nation. From New England to Georgia, this zone produces minerals of a diversified nature. A partial list of them includes iron, copper, zinc, tungsten and such important nonmetallics as asbestos, coal, mica, feldspar and clay. And for that matter, prior to the gold rushes of the West, our entire output of the yellow metal came from such states as Virginia, North Carolina and Georgia.

The Appalachian uplift can therefore be considered favorable prospecting territory, especially since it has not had the close scrutiny the West has received. Commenting on this point, Doctor Boyd noted that there is scarcely a vein outcropping in the Rockies that has not had from one to a hundred holes dug in it by inquisitive mineral seekers.

The Appalachians have not experienced intensive prospecting because vegetation and topsoil are much heavier there than in the West and fewer lodes are visible on the surface. There is no reason, though, why they shouldn't be as plentiful there as in the western cordillera, and man's new geophysical and geochemical tools can ferret them out. Recent proof of this is the discovery in Pennsylvania by Bethlehem Steel Company of large bodies of iron ore buried 1500 feet beneath the surface. Located in Berks County, not far from Bethlehem's long-worked Cornwall Mine, these deposits are now being developed by shafts and connecting underground workings for the production of thousands of tons of ore daily.

Where Bethlehem has pointed the way, Kennecott is preparing to follow, and other large concerns will doubtless also give the oldest mountains in the nation a good looking over in the coming intensive quest for new mineral wealth to bolster our lagging output.

DIG AND SURVIVE!

AFTER mankind learned to build shelters aboveground he shifted his domicile from caves and for a long time thereafter the art of excavating was less important in his life than it had been before. Later, as he found out how to make things from metals, he began burrowing for ores. Since then *homo sapiens* has dug primarily to extract something from the earth. Exceptions are, of course, burial places and, in recent times, trenches or tunnels for various forms of transportation and shallow openings for foundations of dams and buildings.

Many centuries have passed since our ancestors sought protection in natural caverns or those they painstakingly gouged out of the ground, but the pendulum now seems to be swinging back. Modern instruments of warfare have made people cave-conscious again. This is true in both military and civilian circles.

In World War II the Maginot Line and the Westwall were hailed as impregnable subterranean fortresses. Neither proved to be that resistant, for man can destroy anything he can build, but they were conquered at heavy cost in armor and blood. That was the era in which the sapper and the engineer became important on the battlefield. Underground strongholds on many of the Pacific Islands were heavily relied upon by the Japanese in World War II, and at Iwo Jima, Okinawa and elsewhere they held off attackers for long periods.

The Communist forces in Korea are now following similar tactics, and subterranean defenses are highly effective in the static warfare that is being waged there. Early this year our foes boasted openly of the strength of their hidden fortifications. These burrows are so spacious, it is reported, that the men in them can watch movies and eat hot meals in comparative security, sometimes within a few hundred yards of the UN lines. According to dispatches sent out by the New China News Agency (communistic), "Thousands upon thousands of men have worked in lamplight underground, day and night, during the past year, disemboweling the mountains." UN forces have likewise done much excavating, and in the stalemate that exists much of the time advanced troops on both sides spend most of their hours below the surface. Observation of these con-

ditions elicited from Hanson W. Baldwin, military expert of the New York *Times*, the comment, "To dig is to survive and 'Dig, soldier, dig!' will be the first order on tomorrow's battlefields."

Among civilians at home digging has also taken on additional meaning. Shelters born of fear of atomic explosions have been provided in lands thousands of miles from present fighting areas. Many of them are designed to protect not only people but also corporate records and works of art. Such underground repositories are being developed in different parts of the United States, especially in sections readily accessible from large centers of population along the Atlantic Seaboard.

Old mine openings are adapted for the purpose in many instances, thus saving time and expense. A United States Steel Corporation publication recently described a facility of this type that the huge industrial concern has outfitted in an undisclosed location somewhere near New York City. It already contains approximately 50,000 cartons of paper records and thousands of rolls of microfilm, and new shipments arrive daily from 117 points in the country where the company's twelve subsidiaries operate. From these archives it would be possible to reconstruct a balance sheet for any of the firm's units for any given period.

Fully equipped offices have been set up in the subsurface repository for the staff that administers it, and both temperature and humidity are controlled in the storage area. Two portals give access to the caverns—one served by trucks and the other by a narrow-gauge railroad used for haulage in the still active adjacent mine workings. All told, 75 acres of space has been allotted to the safe-deposit project, but only a small fraction of it has so far been put into service.

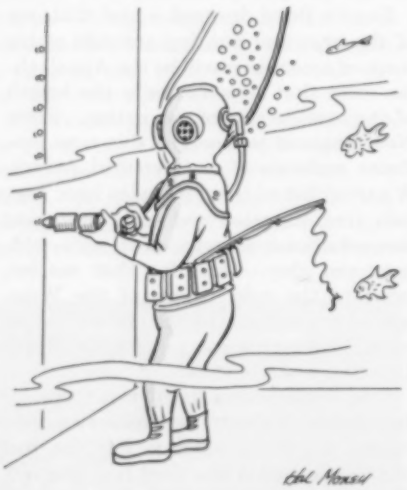
This and That

UN Seeks to Change Methods

Interesting sidelights on agricultural and industrial methods in other countries are to be found in the voluminous reports on the various activities of the United Nations organization. A digest of UN proceedings called *Briefing*, reports, for instance, that Afghanistan farmers have heretofore dumped sugar-beet pulp in the Khundiz River, although in the United States it is considered such an excellent food for livestock that it commands a price of $95 a ton. Experts of the UN's Food and Agricultural Organization who sought to persuade them to use the by-product met with little success at the outset. There was a superstition that the pulp would poison the animals, and the natives therefore refused to let the FAO representatives have their stock to prove the beneficial effects of the feed. "I don't want my livestock to die," was the reply they got from all.

Finally they prevailed upon a beet-sugar manufacturer, who stood to gain financially if the experiment was successful, to buy 25 head of cattle and 25 head of sheep for the demonstration. The livestock was placed in an enclosure and fed a diet of beet pulp mixed with molasses, cottonseed cake and wheat straw. Native farmers who came to watch the animals die noticed that they got fatter and friskier as the days went by. After about a month had passed, it was seen one morning that the herd was larger. It continued to grow and finally reached 400 head. Then the Afghani farmers began driving their cattle into the feed lot to let them sample the pulp free of charge. From now on none will be thrown away and the cattle and sheep will grow faster and be freer from disease.

Another report tells how little the people of the Himalaya Mountains know about winter forest work. Traditionally, they stop logging in the autumn, not knowing that in other countries woodsmen do most of their hauling on sleds after the snow falls. It is expected that it will be a major job to change the long-formed habits of the inhabitants who now have no sleighs, no adequate cold-weather shelters, no proper tools or clothes for winter operations. It is believed, therefore, that a trained logging crew will have to be sent in to demonstrate the advantages of winter work to make an impression on the lumbermen who carry timber down the mountains during the summer months.



Mapping the Sea Bottom

For 150 years a coal seam has been worked underneath Ayr Bay in the Firth of Clyde off the southwest coast of Scotland. In the interest of safety, the operators are permitted to extract only 50 percent of the coal and must leave the remainder in the form of pillars to support the overlying ground and water sufficiently to prevent faulting or fracturing.

Where the shafts reach them, the workings are slightly less than 600 feet deep. The seam is fairly level but does rise about 1 foot in every 20 or 30 feet as it extends farther into the sea. In 1951 the working faces were half a mile offshore and only about 470 feet below the surface. As the coal bed was still sloping upward, it was deemed advisable to find out exactly how much and what kind of cover there was over it. This involved mapping the contour of the seabed and sampling the rock of which it is composed. The first operation was performed by means of echo sounding apparatus and the second by standard rock drills.

The echo sounder used sends out a short sound wave from the bottom of a ship. Its recorder registers the time required for the resulting echo to return from the seabed and converts it into a depth measurement. With the boat making 6 knots, soundings were taken at a rate of nine per second, or at linear intervals of approximately 1.14 feet. The 25-foot launch traveled a straight course at right angles to the shore, and runs were made on lines 100 yards apart until the whole area had been covered. The contour of the sea floor was plotted from the readings.

Next it was necessary to determine the nature of the rock bottom and the thickness of the overlying sediment. The latter information could have been obtained by aid of various types of equipment, but a technique had to be devised that would also provide specimens of the rock. After several methods had been considered, it was decided to use an ordinary air-powered drill of the Jackhamer type.

Operations were carried on from a 2-level staging swung out over the side of a 67-foot steam-driven boat. The drill weighed 105 pounds and slid up and down in a guide frame. Both were suspended from lines extending from the ship's derrick to winches on the deck. A casing made up of 5-foot lengths of 2⅜-inch pipe was run through the soft material down to rock, and the drill's 1¼-inch steel with a 2¼-inch gauge 4-point detachable bit was operated inside of it. Air was supplied by a 200-cfm-capacity compressor powered by a diesel engine.

At each drilling location the boat lowered six anchors to hold it steady while work was in progress. The drill served

to drive the casing into the sand until it was held firmly by the loose material, and successive lengths were added as needed. When drilling got underway, the water sent down through the hollow steel sufficed to lift the sand, lowering the casing progressively until it was seated on rock. Then a hole at least 5 feet deep was drilled to make sure that it was not merely a boulder. Throughout the entire period of both casing and drilling, the excavated material brought up by the water was run into a bucket and preserved to show the character of the seabed. In all, fourteen bore holes were put down, and the entire job was completed in six weeks.

It was found that relatively calm weather was required to do the work satisfactorily by the method outlined. Under proper conditions, coupled assemblies of drill rods up to 150-200 feet long functioned well. From the data obtained, a map was prepared to show the underwater topography in considerable detail. It was possible in this manner to project the thickness of the rock cover over the mine openings far seaward of the present working places and to gain a fair knowledge of the character of the protective mantle. It is expected that the mine can be safely advanced up the slope of the seam until the thickness of the overlying rock has been reduced to 270 feet.

★ ★ ★

Blood from a Turnip

One of the world's most persistent men and perhaps its greatest optimist is Jacob Beck, who for twelve years has been doggedly seeking petroleum in a place where geologists say he hasn't a chance of finding it. Intermittently, since June, 1940, he has been drilling in Monroe County, Michigan, and according to last report a cable-tool rig is still pounding away there. The peculiar point about the venture is that the tools are working in granite, a rock that was born in heat and fire. No one has ever struck crude oil in it, and geologists claim it just can't be formed there. They hold the theory that oil comes from vegetable or animal matter that was laid down with sedimentary strata, and so far all the productive wells have penetrated such rock.

Regardless of these postulates, Beck still thinks he will win out and keeps on trying to prove that the experts are wrong. It's a rather costly whim: the latest contract, let to William R. Albers, calls for an outlay of $50 per foot. Progress is at the rate of an inch an hour—a foot in a 12-hour working day. After drilling 3 or 4 inches of hole, the bit has to be withdrawn for sharpening. The hole entered granite 3595 feet below the surface and has so far gone through about 1900 feet of it, having reached a depth of more than 5500 feet.

Others before Beck have tried in vain to coax petroleum from granite. His well even has a long way to go to set a record for drilling in this basement rock. One put down 80 miles from Toronto, Canada, some years ago penetrated 2375 feet of granite. Another wildcat, in southern New Jersey, passed through 3680 feet of schist, a metamorphosed igneous rock, before being abandoned at a depth of 5022 feet.

★ ★ ★

Robot Lawn Mower

The lazy man's prayer has been answered by Fairbanks, Morse & Company with a lawn mower that operates unattended. Called the "grass finder," the remarkable machine has mechanical "feelers" that pilot it along the edge of a swath that has been

THE "GRASS FINDER"

It should be popular with golfers, fishermen and tired businessmen. The machine finds its way around with the "feeler" at the right.

cut. The operator has only to mow a strip around the outside of the plot of grass, then put the machine on its own.

The mower will, it is claimed, find its way unerringly around curves and corners, working towards the center of the progressively diminishing unshorn area. After finishing the job, it will continue to move in a small circle until it is shut off or moved to a new place. Powered by a gasoline engine, the unit will negotiate grades up to 20 percent and can cut grass from 2½ to 7 inches high.

Operating on a clockwise course, the automaton veers to the right until the mechanical feeler on the left-front side contacts tall grass. This releases a control that causes the machine to go straight ahead until the feeler reaches cut grass, whereupon the mower again weaves to the right.

As grass is cut, it is thrown to the right in the path of the machine on its next time around. The snips are consequently mulched and remulched, being reduced to a size that makes raking unnecessary. The "grass finder" sells for a little less than $300.

★ ★ ★

De-icing Reservoir with Air

Since around 1929, hydroelectric generating stations in various parts of the country have been using bubbles of compressed air to prevent ice from forming in front of gates and along other sections of the dams that impound their operating water. This simple system is effective at temperatures down to zero or below, and during the past two years sawmills in cold climates have adopted the same scheme to prevent their log ponds from freezing over and thus permit operations to continue throughout the winter.

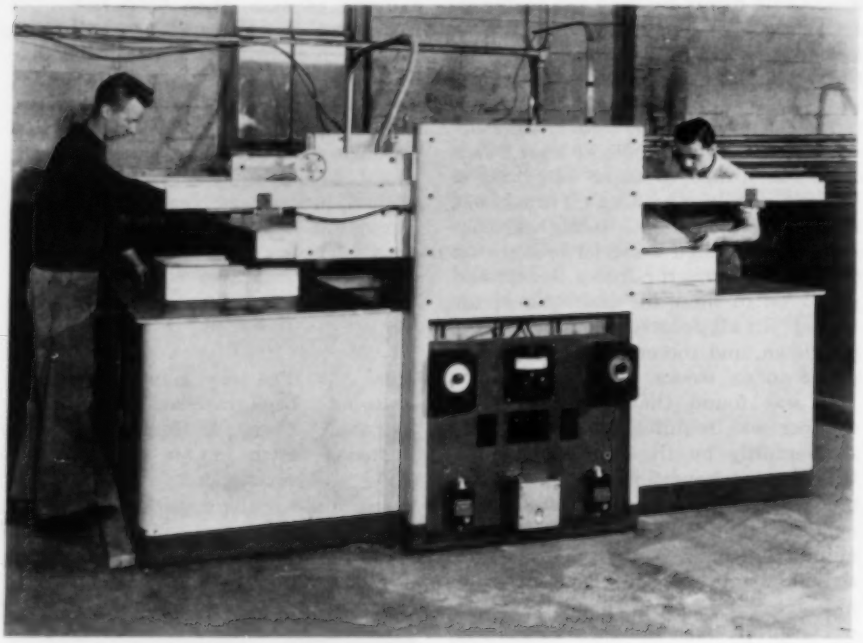
At Safe Harbor Dam, on the Susquehanna River, the Pennsylvania Water & Power Company recently tried the method to keep a channel open upstream from the dam. For this experiment, 1000 feet of 1- and 1½-inch galvanized pipe was laid on the bottom of the reservoir, which is approximately 50 feet deep at the dam. The line was perforated at 20-foot intervals with holes ranging in diameter from 0.1015 inch to 0.11 inch and compressed air at 100 psi pressure was introduced from the station's distribution system. To limit air consumption to the volume required, an orifice plate with a 9/23-inch opening was inserted in the supply header. It was found that 200 cfm of free air was needed. A by-pass was run around the plate to permit admitting a full head of air into the pipe should it become necessary to clear clogged holes, but no occasion to use it has as yet arisen.

Because it was originally thought that the line would become buried in silt in the summer if it were allowed to remain in place all year, it was planned to lay flexible metallic or plastic piping each autumn and remove it the following spring. Experiments showed, however, that the expected silting did not occur, and the galvanized line has therefore been left on the bottom since it was laid in the winter of 1949-50. If further experience confirms the results obtained to date, the piping will be extended for the purpose of maintaining open-water channels to assist in breaking up the ice and directing it to the crest of the dam, where it can be discharged through gates. It is hoped that the reservoir can eventually be kept relatively free of ice in this manner.

Vacuum Machines Make Short Work of Molding Plastics

VACUUM-FORMING of thermoplastic sheets, long in the offing, is now being done on a production-line scale by machines developed by the Auto-Vac Company. The process was first used to make relief maps from preprinted plastic sheets at the start of the Korean campaign. Though too expensive at the time for general application, the results obtained were so encouraging that further experiments were conducted to improve the method—make it commercially practical. That has been achieved, and today vacuum-forming machines are doing decorative embossing and turning out a wide variety of things including toys, lighting fixtures, television and radio cabinets, kitchen accessories and containers for consumer goods. In fact, cases are being manufactured for delicate instruments, for example, that are identical in shape to hug them closely and thus give them maximum protection.

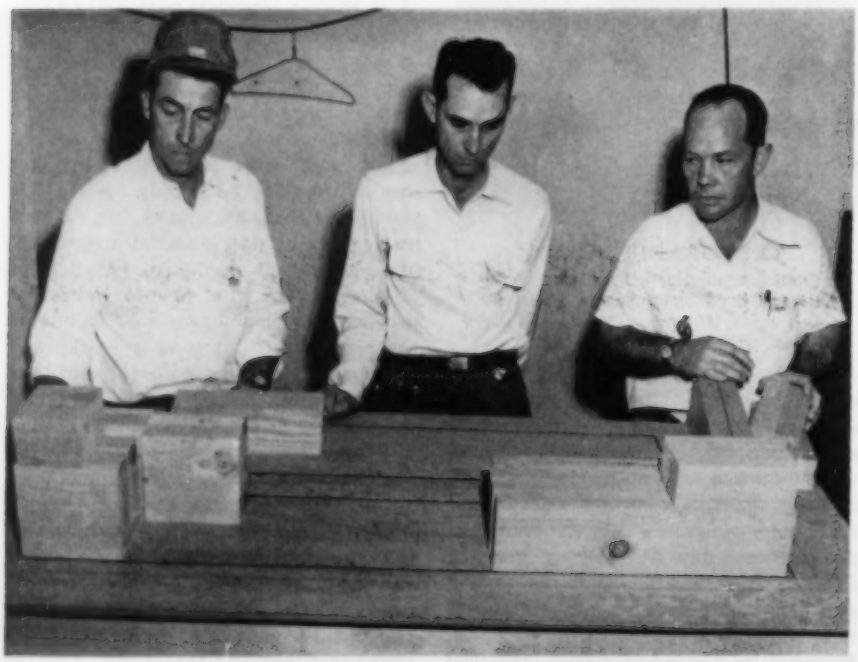
The process is a relatively simple one and considerably shortens the period between designing and production. It only involves clamping the plastic material, cut to size, to a single-die mold, heating it under controlled conditions and evacuating the space between the sheet and the form. This draws the now pliable plastic in close contact with the mold and shapes it. When removed after cooling and hardening, the product is essentially finished. Preprinting the sheet in advance of manufacture, as in the case of maps, dispenses with masking and unmasking necessary for spray or brush painting.



TWIN-TABLE MODEL

This 30x50-inch machine is designed to operate on a production-line basis. While the man at the left is clamping a sheet of plastic on a mold for forming and the one at the right is removing finished work, a part is being shaped by the application of heat and vacuum. Single-table models are suitable for plants where output is light.

Among the plastics that lend themselves to vacuum-forming are polystyrene, polyethylene, acetate, butyrate and all vinyl polymers. Sheets up to 60 feet square may be molded in a single operation, and material from 0.001 to 0.125 inch thick can be shaped under proper heat control without noticeably affecting its strength. Parts that must be machined or resist stresses in use can therefore be made by the process. In 1950 there were twelve vacuum-forming machines in operation; today there are 150 ranging from 17x21-inch units for the production of small novelties to 48x72-inch machines for large items.



THEY PLAY WITH BLOCKS TO SAVE MONEY

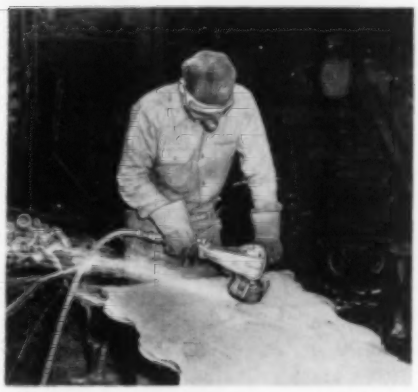
These men maneuver wood-block models of shipping crates on a freight-car floor, both built to scale, to find out how best to load shipments from TEMCO Aircraft Corporation, Dallas, Tex. Before the scheme was developed by R.S. McClendon, general foreman of the concern's wood shop, car loading was difficult and time-consuming because the crates are of different sizes and shapes. Sometimes cases had to be removed and rearranged to better fill the available space. Now loading is planned in advance by manipulating the blocks. Once they are in place, they serve as visual guides for the crews.

Railcars are Popular

IN SWEDEN, where the government operates the 10,300-mile railroad system which employs one man in every 30 inhabitants, diesel engine-driven railcars are so popular that 800 additional units are being built, with 100 earmarked for 1953 delivery. They are used primarily in zones of light traffic, and anywhere from one to ten cars constitute a train. Each unit weighs 17.4 tons, as compared with 40 tons for a standard railway car. Trains made up of several units run at speeds up to 70 miles an hour and are well equipped with safety devices. Operation is controlled by a multiple pneumatic-electric system safeguarded by an oil-pressure pilot that cuts off the engine and disengages the couplings when the pressure of the lubricant becomes inadequate and the radiator cooling water becomes overheated.

Industrial Notes

For surface grinding, cutoff and sanding jobs, Ingersoll-Rand Company has introduced an air-powered Angle Grinder of unusual construction in that it features direct drive without the use of gears of any kind. With air at 90 psi pressure it has a speed of 6000 rpm. Designated as Size 2FA-60, it is obtainable with



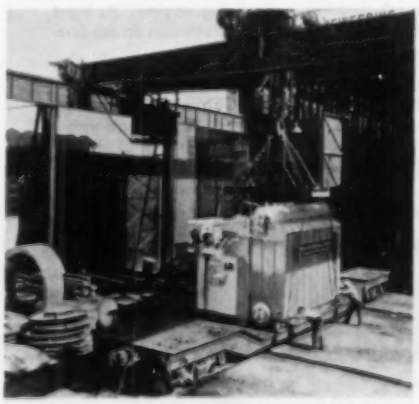
two types of handles that may be attached to either side of the grinder. One is straight and the other at a 30° angle. The latter can be rotated to any one of four positions, thus making the tool suitable for corner grinding or for a right- or left-handed operator. Other characteristics are a built-in lubricator for long, trouble-free service; an adjustable exhaust deflector on the bottom that directs the exhaust away from the worker; heavy-duty ball-bearing construction that reduces friction and maintenance to a minimum; and a motor equipped with a muffler to lessen noise. An additional model operating at 8000 rpm is available for special applications.

Two volatile nonflammable solvents for cleaning electrical equipment have been put on the market by Northwoods Mfg. Chemists, Inc. Designated as DMC and EMC, the former is sprayed on instrument panels, heavy motors and the like to rid them of oil-soaked deposits, while the other is suitable for cleaning small motors, which are immersed in the fluid in a closed tank and allowed to run for three to five minutes under their own power. The units are ready for service after drying with compressed air. If of the ball-bearing type, the treatment does not affect the lubricant in the bearings, it is claimed; but if sleeve oiled, the reservoirs have to be drained before submergence.

Masks used in spray painting are easily cleaned with safety, it is claimed, by a portable washer developed by Sepanski & Associates. The machine has a hinged lid through which the work is introduced and a solvent reservoir in the base from which the solution is forced with air under 50 psi pressure through multiple nozzles disposed so as to cover every part of the mask. The solvent used depends upon the coating to be removed, and that, in turn, determines the length of the operating cycle, which is set by a timer and started by a foot-control valve. There are two models with 5- and 10-gallon tanks and cleaning chambers to take masks up to 14x16 and 16x33 inches in size, respectively.

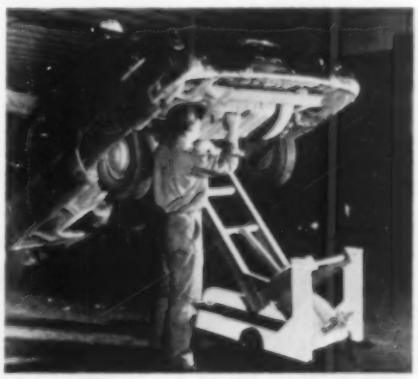
Radar has been helping public utilities for some time to find breaks in overhead electrical transmission lines. Now it is performing a similar service in connection with buried cables. The new trouble shooter, called Radar Fault Locator, was developed by Commonwealth Edison Company and Public Service Company of Northern Illinois and is based on the same principle as military radar except that the impulses are sent over a wire instead of through the air. In operation, the locator is simply hooked up to one terminal of a damaged line. When energized, the impulses travel to the point of breakage and back to the transmitter, which records the time it took to make the round trip. The approximate location of the fault is established simply by converting the elapsed time into distance.

A new line of standardized water-tube boilers operating in the medium pressure range (up to 250 psig) and for steam capacities ranging from 4000 to 30,000 pounds per hour are being offered by Combustion Engineering-Superheater, Inc. Known as the Package Boiler, Type VP, it is completely shop assembled with firing equipment, setting, forced-draft fan and an automatic control that proportions the air and fuel supply to the needs of the fluctuating load. Lifting lugs are provided so that it can be unloaded and handled by a crane. Designed for pressure firing of oil or gas or both, the unit is based on the long-established 2-drum, vertical-bent-tube arrangement with a water-cooled furnace in front of the convection surface. According to the company, its



ratio of furnace-wall cooling to furnace volume is higher than that of any boiler of like size and kind. This assures rapid and efficient heat absorption, lower-temperature gas entering the convection bank, less slag formation and helps to minimize furnace maintenance. Because of its compactness, the Type VP needs a minimum of floor space and headroom.

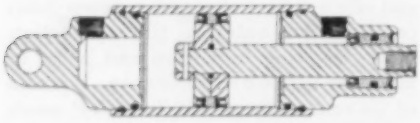
Automotive vehicles of any kind can be easily lifted front or back for servicing or repairs by a portable hoister of the cantilever type that is ready for use with no manual effort other than connecting an air hose. This end lift is being built by Homestead Valve Manufacturing Company and is powered by a pneumatic cylinder in a steel-channel frame mounted on a carriage with hand grips that permit moving it around indoors or outdoors within reach of a source of compressed air. (Recommended operating pressure 120 psi.) There are two models with hoisting capacities of 3000 and 5500 pounds for passenger cars and trucks, respectively. The l'ght-



er unit, Model 3, has a maximum lift of 53 inches while that of Model 5 for heavy vehicles is 50 inches. Both are equipped with an automatic safety lock that is said to hold them firmly at any one of ten working heights most convenient for the man performing the job. Overtravel of the piston is prevented by blowoff ports, which also force water or foreign matter out of the cylinder. When not in service, the hoist is upended for storage in approximately 30 square inches of space.

Pneumatic cylinders of an improved key type in all standard mounts have been anounced by Carter Controls, Inc. Their outstanding feature is a cartridge that is designed to facilitate servicing and to reduce wear caused by misalignment. It is made up of a long bronze-rod end bearing, rod packing and a self-centering packing at the pivot point and can be withdrawn for replacement by a similar unit simply by removing a snap ring. Mounts are of cast steel and are

an integral part of the cylinder heads, which are secured to the cylinder walls by internal locking key rings in counterbored sections that permit removal of the piston and rod from either end without damaging the packing. Pipe



ports can be positioned as desired because the key-type construction permits rotating ends 360°. According to the manufacturer, the design gives a safety factor of ten to one in all bore sizes ranging from 1½ to 8 inches with strokes of any length up to 18 feet.

Many industrial plants, especially those handling or processing foods, must take great care to prevent the breakage of window panes, skylights, etc., lest fragments of glass become mixed with the products. To determine the effectiveness of wire, plastic and other safety glass, the Post Cereals Division of General Foods Corporation has undertaken a series of tests and discovered that ordinary double-strength glass coated on both sides with a plastic solution is highly resistant to impact. When struck, the pane fractured, but the plastic held the pieces together except in the case of a very severe blow, while a wire-protected pane showered the surrounding area with considerable powdered glass and slivers. The liquid was applied by spray gun with air at 30 psi, and the cost of coating a 14x20-inch sheet, with material, amounted to $0.025.

With industrial diamonds in short supply, users of diamond grinding wheels from 3 to 7 inches in diameter may be interested in a Vap-Air-Exhaust, a dual-purpose machine that salvages diamond dust. First, in accordance with federal regulations, it applies a controlled quantity of coolant to the center of the wheel so it will be evenly distributed on the wheel. Excess coolant is drawn by suction into a hood, that can be readily adjusted and attached to any grinding setup. Next, an auxiliary spray built into the hood continually flushes the exhaust hose and fan to keep them clean for efficient operation. From the sludge, which collects in a large detach-

able pan at the bottom of the unit, the diamond dust can be reclaimed without difficulty. The machine was designed and is being built by The Shelboerg Mfg. Company and is said to increase the service life of grinding wheels from two to three times and to effect savings in diamond grinding costs from 60 to as much as 75 percent.

Clogging of screens and filters of industrial oil burners is prevented, it is claimed, by Santolene H, a fuel-oil additive announced by Monsanto Chemical Company. A nonmetallic-base compound, it inhibits the formation of sludge and sediment, keeps sludge already present in suspension, and markedly checks corrosion. It is used in the ratio of 3 gallons to 42,000 gallons of fuel. Half that amount is adequate when mixed with oil to protect handling and storage equipment against rust.

Dollinger Corporation has announced a small pipe-line filter designed for installations using air or gases at pressures not exceeding 40 psi. There are four models and two sizes that will take either the company's original radial-fin insert or fine-textured felt absorption pads. The air enters at the top and is directed at high velocity against the wall

by aid of a deflector cup. Entrained moisture and solids are trapped in the bottom while the air rises and flows at low velocity through the filtering medium. The radial-fin or CH Series serves primarily to remove dirt and scale and

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The NEW Model VG4D is an exceptionally smooth-running, even-firing engine. Its light weight and compactness in design simplify the problem of engine installation on modern equipment where weight and space limitations are important factors.
Every one of the traditional Wisconsin 4-cylinder features are built into this new model. These include, to name a few, tapered roller main bearings, dynamically balanced forged crankshaft, mirror finish on crank pins, Stellite-faced exhaust valves and valve seat inserts and honed cylinders for long, dependable, heavy-duty engine life.
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the AA Series to rid air of oil and water vapor. A drain plug permits withdrawal of the condensate without shutting down the line, and the filter's one-bolt construction facilitates access for inspection and cleaning. The models have ¼-inch pipe connections, are 3½ inches in diameter and either 6½ or 10 inches long.

The Bristol Company has announced a miniature pneumatic measuring instrument that is designed to transmit readings of temperature, pressure, vacuum, differential pressure and liquid level to recording, indicating and controlling receivers. Designated as the Series 650, it embodies standard Bristol measuring

elements and a transmitting mechanism with but one pivot and no flexures to cause friction and lost motion. Transmission is effected by means of air at 3 to 15 psi pressure that has a direct relation to the measured quantity, and a pneumatic relay insures high-speed transmission and reliable control. The unit weighs 7½ pounds, is weatherproof, will operate in any position and is said to be sensitive to extremely small changes in the measured value.

Portland cement combined with chemically mineralized wood shavings are molded under pressure into a building material by Durisol Incorporated. According to the manufacturer, the planking is proof against rot, vermin and termites; can be worked with carpenter tools, nailed or held in place by screws, clips or mortar; and covered directly with plastic, stucco or concrete. Called Durisol Plank, it is suitable for use as flooring, roofing and wall panels and is made in varying lengths up to 10 feet, in widths ranging from 16 to 24 inches, and 3¼ and 4½ inches thick.

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HOSE CLAMPS

When a *leakproof* hose connection is called for, it's only natural to think of Punch-Lok hose clamps. These are the clamps that are *locked for safety* . . . locked to prevent slippage.

That is why the Kellogg Division of the American Brake Shoe Company chooses Punch-Lok hose clamps for its Kellogg-American steam spray guns.

In addition to applications such as this . . . Punch-Lok hose clamps are also used extensively for leakproof connections on air, water, and steam hose.

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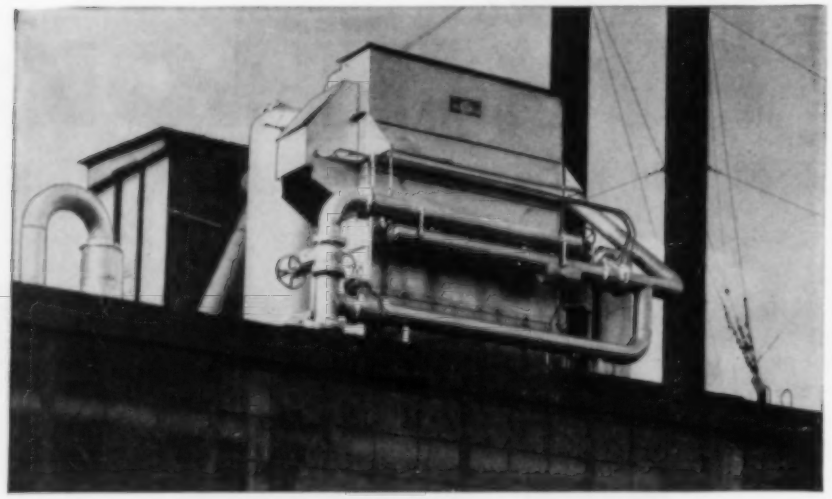
Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

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QUOTES

—FROM HERE AND THERE

Air Jet Solves Chip Problem

Raymond G. Hawkins of Oakdale, Calif., writes in *American Machinist* of February 16:

"In boring small cored holes in brass nozzles, the finished bore is very little larger than the boring bar and chip clearance is practically nil. To overcome this condition, I rigged an air jet to throw a blast of air through the hollow lathe-spindle.

In addition to clearing the fine boring chips, I find that the workpiece temperature is kept lower and have been using it for this purpose even when no chip problem exists. If necessary, a baffle can be placed at the tool end of the work to prevent chips from flying out.

The jet assembly consists of copper tube fittings on a pivoted arm, held in place with a thumbscrew. For long bar work the unit can be swung out of the way."

Pneumatic Transport System in Flour Mill

"Some of the world's most advanced ideas in milling have been put to use in the General Mills new whole wheat mill at Buffalo, New York.

For instance, air replaces bucket lifts in moving flour stock through . . . a network of streamlined 3½ in. tubes at a rate of 4500 fpm. Bucket elevators in the mill used to move at only 340 fpm. Now, with this faster system, much less space is taken up by transport facilities.

A feature of the new mill is a set of cyclone collectors made in Switzerland. Fast moving, stock laden air enters the funnel-like cyclone chamber from the top and spins rapidly inside. The stock falls

"Yes, we're hiring, but you'll have to start at the bottom of the ladder."

to the bottom and air continues out the top. This, say engineers, is a highly efficient operation giving 99½ per cent complete separation of stock from the air."

The Modern Millwheel, General Mills, Inc., Minneapolis, Minn.

Pneumatic Casts for Medical Use

"Flexible rubber bags that harden instantly when evacuated by vacuum pump are being used in medical treatments to quickly immobilize various portions of the body. The Flexi-Cast is filled with fine-grained plastic granules and can be adjusted to fit around any part of the human body or all of it. It becomes very rigid when all of the air is evacuated and malleable, like putty, when only part of the air is removed. The rubber bag may also be used as a mold to make impressions of the face, head, or other parts of the body."

Chemical Processing, March, 1953

Nuisance of Waste Pickle Liquors Solved?

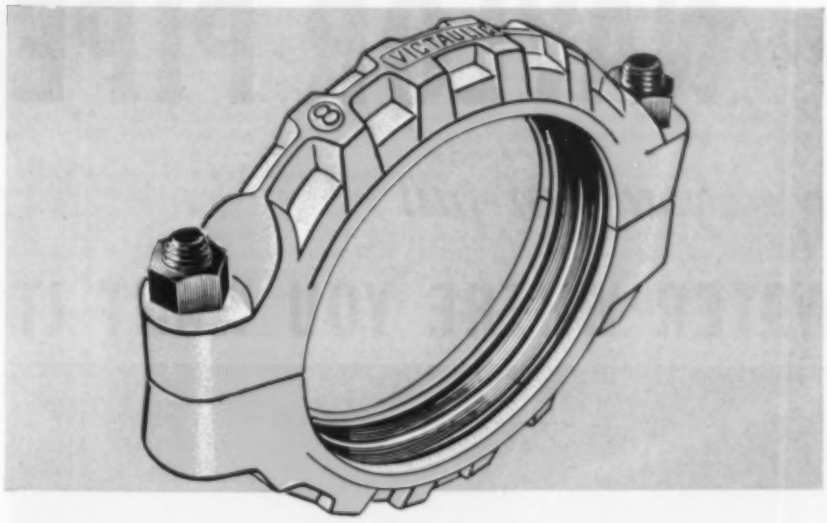
"Most significant advance to come to the front in years in the treatment of waste pickle liquors is the term being applied by experts in the field to the new Ruthner process, developed in Europe and being handled in this country by Blaw-Knox. Waste liquors are treated with gaseous hydrochloric acid to precipitate ferrous chloride and regenerate pickle solution. Ferrous chloride is calcined to give back hydrochloric acid. Residual iron oxide can be sintered for blast furnace. Hard pressed for a cheaper disposal method, steel companies are taking a good look at the new process. A firm proposal is already in the works for one major installation."

Steel, March 30, 1953

Power from Wind

"Nearly a hundred years ago Abraham Lincoln said, 'Of all the forces of nature, I should think the wind contains the largest amount of motive power.' These words were hardly prophetic, but even today in the atomic-jet age windmills are a familiar sight on the vast cattle ranges of the West and on farmsteads remote from rural electrification. Within the past generation more than 1,500,000 windmill heads, including wheels, gears and other mechanisms, have been produced in this country and 800,000 towers to accommodate them have risen, according to the American Iron & Steel Institute. The windmill is older than the Christian era, and famous inventors, including Leonardo da Vinci, have contributed improvements to it."

From the financial section of The New York Times



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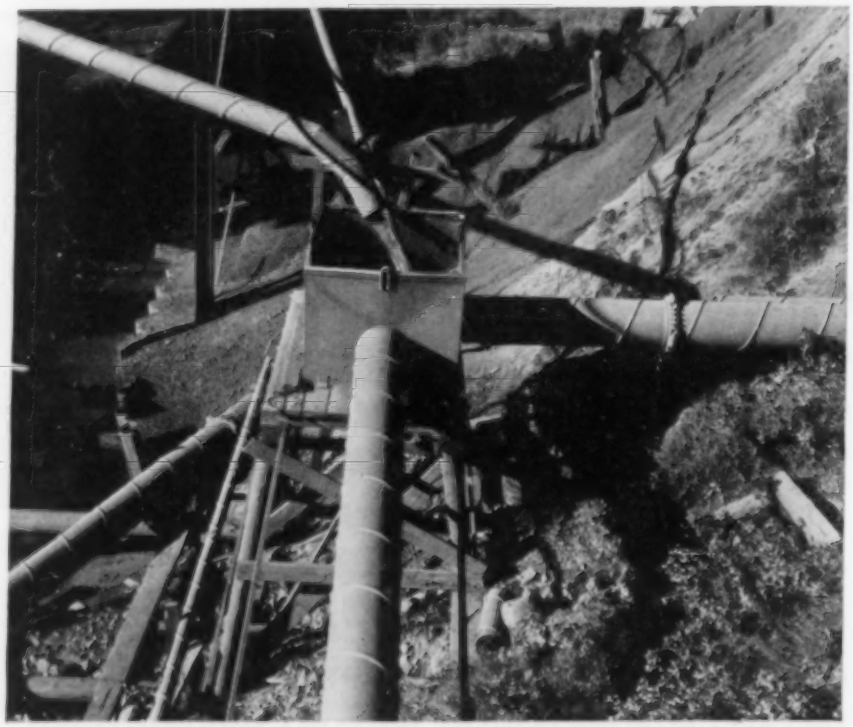

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The extra strength and safety built into this distinctive lock-seamed spiralwelded light-wall pipe enable you to use it on even the toughest piping assignments without fear of failure.

It's easy to handle. It's easy to install. It performs equally well in high or low-pressure service on air and water lines. It's the all-around, economical pipe for mining applications.

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Books and Industrial Literature

The Heat Exchange Institute has announced release of the third edition of its book on *Standards for Steam Surface Condensers*. One of a series of eight publications on heat-exchange apparatus, it has been completely rewritten since last issued in 1939-40 and definitions have been clarified. Of 17 pages, it contains new data that is based on tests and includes corrections in heat-transfer rates for different tube materials and curves that more nearly illustrate actual maximum performances. There is a new section on surface-condenser sizes, and the chapter on vacuum-pump and rapid-evacuator capacities has been revised. The object of the book is to help purchasers of condensers by setting up standards of heat-transfer rates and performances and to give engineers information essential to writing specifications and designing surface-condensing equipment. Copies can be obtained through members of the Heat Exchange Institute or from its headquarters, 122 East Forty-Second Street, New York 17, N. Y. Price, $2.00.

A reference book on motors and generators to assist purchasers in selecting motive power to meet the requirements of most industrial applications can be obtained free upon request from Allis-Chalmers Manufacturing Company, 1000 South Seventieth Street, Milwaukee, Wis. Of 50 pages, the book (51R7933) is a reprint of one section of the 1952 edition of *Lincoln's Industrial-Commercial Electrical Reference* published by the Electrical Modernization Bureau, Inc., White Plains, N. Y. Price, $18.75.

A flier dealing with the designing, manufacturing, sharpening and reconditioning of microprecision broaches, bars and fittings for jet-plane and allied industries is offered by Cleveland Broach, Inc., 1061 East 260th Street, Cleveland 23, Ohio.

Data on findings of a recent study of failures in threaded pipe joints have been made available by the Chicago Gasket Company, 1275 W. North Avenue, Chicago 22, Ill., in Bulletin No. B7A, which also contains information on the firm's Graycoat plastic sealing compound.

A 12-page bulletin (S-22-CA) issued by The Swartwout Company, 18511 Euclid Avenue, Cleveland 12, Ohio, describes and illustrates its diaphragm-operated spring-opening-and-closing regulating valves, pressure controllers, air locks, valve positioners and selector panels.

Tobwy Manufacturing Corporation, 1221 El Segundo Boulevard, El Segundo, Calif., maker of lightweight materials-handling equipment, has issued a catalogue illustrating and describing its complete line of aluminum A-frames, stack racks, worktables, tote boxes and trucks.

Bulletin No. 2-6-1 released by AiResearch Manufacturing Company, 9851 Sepulveda Boulevard, Los Angeles 45, Calif., describes its redesigned pneumatic temperature-control unit for aircraft systems. It contains schematic diagrams and operation and performance data.

Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill., is distributing a reprint of a paper on *Modern Steel Bolting for Piping and Pressure Vessels* originally presented at the seventh annual American Society of Mechanical Engineers Petroleum

Division Conference. Anyone interested in the proper selection of bolting materials can obtain a copy free of charge.

Technical data, construction features and recommended applications are included in the descriptive material in a bulletin on Hankison Condensifilter Model B-30-D that is designed to provide instrument-quality compressed air from ordinary shop air. Hankison Corporation, 951 Banksville Road, Pittsburgh 16, Pa., will furnish copies on request.

Republic Manufacturing Company, 1930 West Seventy-Seventh Street, Cleveland, Ohio, has announced the availability of a 44-page catalogue (No. 352A) that deals with its needle, globe, plug, check, relief and special valves and contains a section on gauge protectors and snubbers, bleeders, etc. Also includes information on the materials of which they are made and shows structural details.

The Specialties Division of The Torrington Company, 500 Field Street, Torrington, Conn., is distributing a folder illustrating and listing small precision parts custom made of metal "at production prices." Included are such items as pins and pivots; swaged rods, wires and tubing; mandrels for grinding wheels; and abrasive points and polishing wheels.

Simplex Valve & Meter Company, 68th and Upland Streets, Philadelphia 42, Pa., has announced Bulletin 401 dealing with its newly developed H-Meter for measuring water, gas, air, sewage, sludge or other industrial liquors. Of twenty pages, it covers every phase of the mercury flow-type instrument of interest to consulting, plant and purchasing engineers.

Cone-Drive Gears at Work in Materials Handling is the title of an 8-page brochure published by the Cone-Drive Gears Division of Michigan Tool Company, 7171 East McNichols Road, Detroit 12, Mich. It pictures and describes typical uses of its double enveloping worm-gear sets and speed reducers in hoists, cranes, winches and conveyors. Ask for Bulletin No. MH-53.

Bulletin 7277 recently made available by Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., describes its line of AFL process pumps ranging in capacity from 20 to 550 gpm and designed to operate at maximum pressures and temperatures of 300 psi and 500°F, respectively. They are intended for medium-duty service but are said to incorporate features normally found only in so-called heavy-duty types.

Denver Equipment in Every Field, a 12-page brochure obtainable from Denver Equipment Company, 1400 Seventeenth Street, Denver 17, Colo., lists and illustrates its equipment in the fields of ore dressing, mining, coal flotation, ceramics, nonmetallics, oil, food processing, paper, reclamation and sewage treatment. It also describes its testing laboratories and the services they are prepared to render men engaged in research. Ask for Bulletin No. G3-B39.

Celite - The Story of Diatomite is the title of a 28-page well-illustrated brochure recently published by Johns-Manville that should interest both the lay and the technical man. It begins with the origin and discovery of the unique deposit of diatomaceous earth in California known as the White Hills of Lompoc. Succeeding chapters deal with the birth and development of the diatomite industry, mining methods and laboratory work that has resulted in Celite products such as filter powder for water purification, dry cleaning and the processing of foods and beverages; mineral filler for paints, plastics, paper, fertilizers and insecticides; and high-temperature insulating material and catalysts. Copies may be obtained from Johns-Manville, 22 East Fortieth Street, New York 16, N. Y.

What is believed to be the first complete and up-to-date manual on thread milling and thread-milling cutters has been prepared by the Detroit Tap & Tool Company, 8615 East 8-Mile Road, Base Line, Mich. A copy of the 16-page illustrated book (D-52) will be mailed upon request written on company letterhead.

General Electric Company, Schenectady 5, N. Y., is distributing two pieces of literature on its new line of low-voltage (under 600 volts a-c) drawout switchgear and air circuit breakers used with them. Bulletin GEA-5915 deals with the installation and operation of the latter and Bulletin GEA-5916 with the switchgear. Both give details of construction and enumerate the advantages claimed for the improved electrical equipment.

For the benefit of purchasing agents and engineers, Universal Metal Hose Company, 2133 South Kedzie Avenue, Chicago 23, Ill., has published a data book covering its various types of flexible metal hose and accessory products, together with their dimensions, construction and applications. Other information such as temperature ranges is included. Requests for Technical Data Book U-111 should be addressed to A.M. Younger, sales manager.

Proved in the laboratory and in the field, Donaldson Air Cleaners meet all the rigid requirements of air compressor applications. Practically all dust, including elusive "extra fines" is removed to reduce wear on compressor parts; and the oil-trapping upper condensing element reduces oil loss from cyclical "blow back" to a minimum.

Donaldson air compressor Air Cleaners are used extensively by leading manufacturers on units with a wide range of capacities. Write for specifications.

DONALDSON CO., INC.
666 Pelham Blvd., St. Paul 4, Minn.
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Donaldson AIR CLEANERS

When loading in a pitching vein the Eimco centers as it clears the muck pile — cleans up easily under the hanging wall.

CONSISTENT LOADING

"Our Eimco turns in a consistently good loading job," says one operator. "You can always depend on it although it requires only a minimum of attention and practically no maintenance."

Eimco's are heavy-duty machines with gear trains running in oil completely sealed in their heavy alloy-steel cases. Easy to operate, it has wide clean-up with automatic centering to load cars full all the way back.

For rock loading there is no equal to Eimco performance, dependability and economy.

Write for more information on the Eimco best suited to your job.

EIMCO A448

THE EIMCO CORPORATION

The World's Largest Manufacturers of Underground Rock Loading Machines

EXECUTIVE OFFICES AND FACTORIES – SALT LAKE CITY 10, UTAH, U. S. A.

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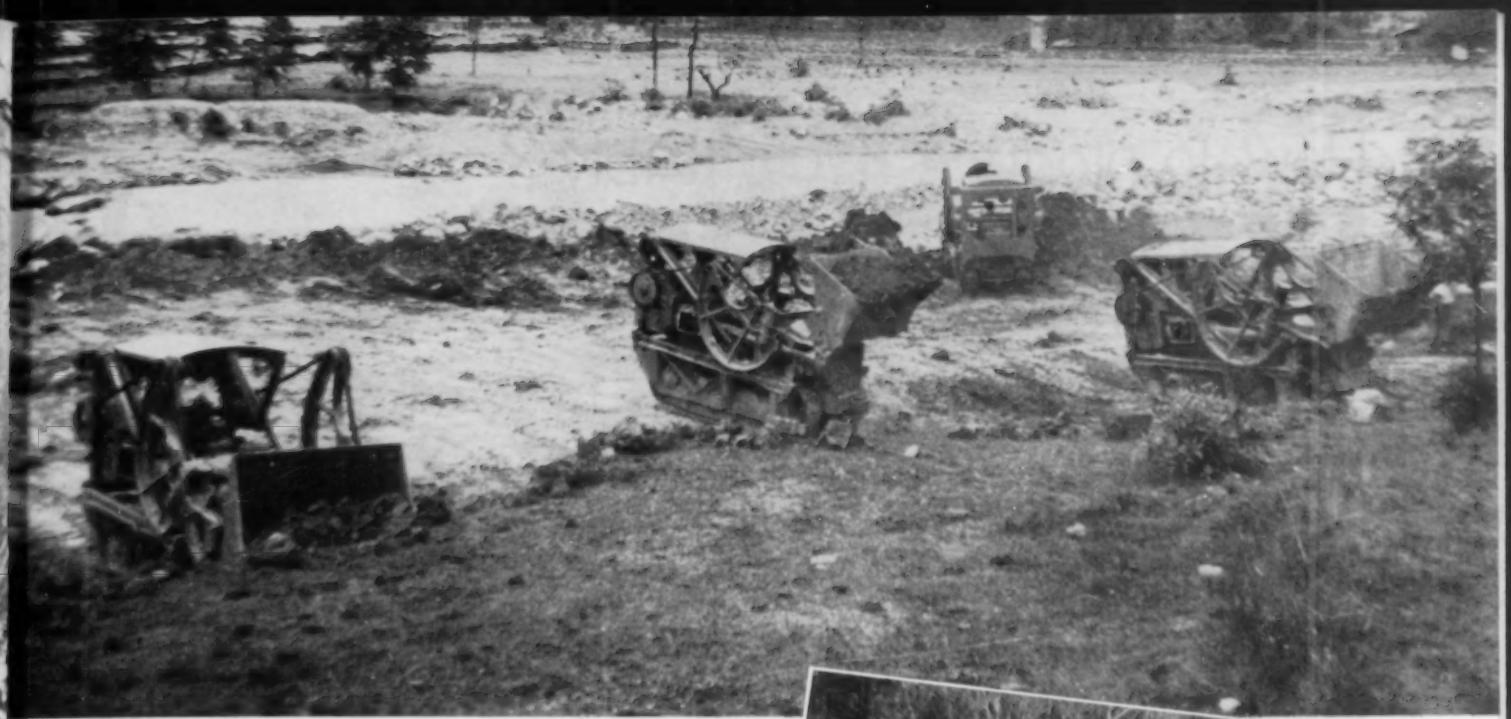
You can't beat an Eimco



Eimcos moving earth for fill to build major link in Pan American highway in South America.

MOVING MATERIAL

Fast

Building levees, highways, for bulldozing, clearing boulders from highways — any job that requires low cost earth or rock moving is best done with Eimcos.

These rugged, heavy-duty loading machines are finding their place in state highway departments, county and municipal road jobs, in sand and gravel pits, in steel mills and among contractors on heavy construction and airport jobs.

Investigate the cost of handling material the Eimco way before you buy.

Above: As a bulldozer. Below: Road building job in Austrian Alps. The shape of the Eimco bucket and the rocker-arm digging action make it possible to pick up and move pieces much larger than with other equipment.

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THE EIMCO CORPORATION

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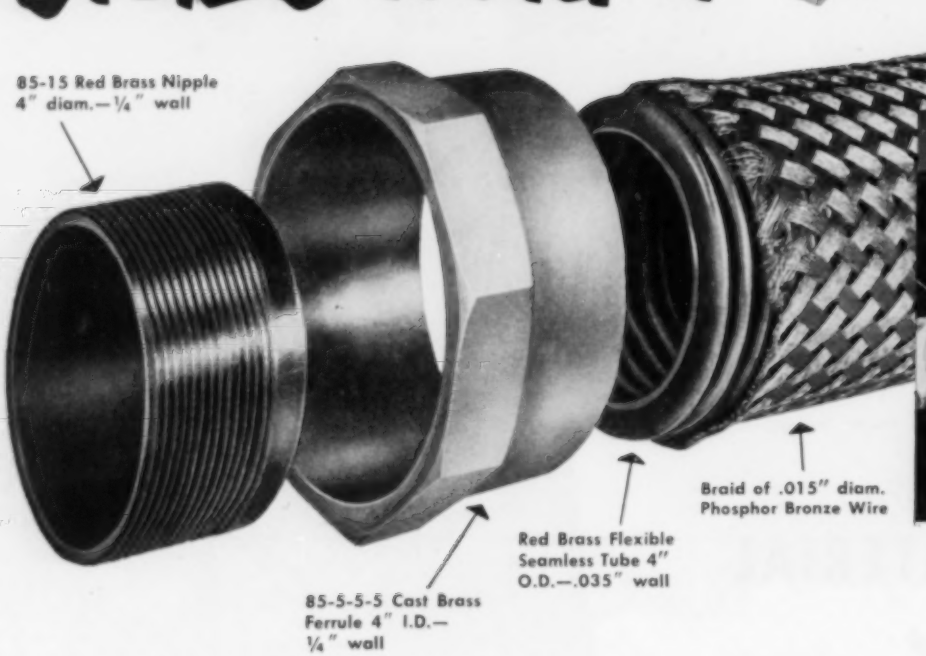
You can't beat an Eimco

How to produce it profitably?

braze weld it—of course!



Braze welding fine wire braid and thin-walled flexible tube into single unit to withstand pressure, vibration and flexing.

This assembly must hold liquids, steam or gas under high pressures—while withstanding vibration and continuous flexing. Made up of dissimilar metals of widely varying thickness, it's braze welded on a production basis with ANACONDA 997 Low Fuming Bronze Rod.

ANACONDA Bronze Welding Rods can keep your welding costs down with fast, strong, uniform welds on even the most difficult production jobs. Our Technical Department will gladly help you with any bronze welding problem. ANACONDA Welding Rods are sold by distributors throughout the United States. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

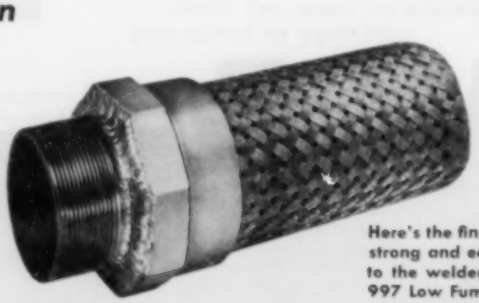
51149

Now the red brass nipple and cast brass ferrule are joined together and to the first weld. This calls for pressure-tight joint between nipple and flexible tube and a strong joint to the ferrule.

For every braze weld, there's an

ANACONDA®

BRONZE WELDING ROD



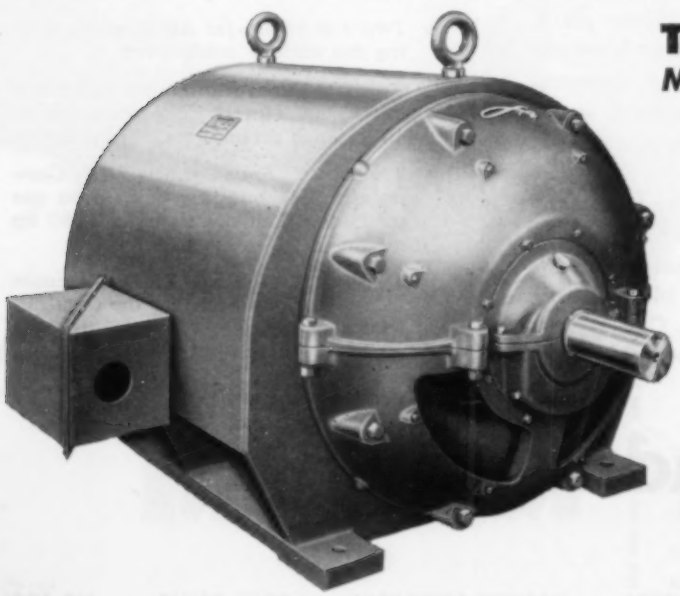
Here's the finished job, neat, tight, strong and economical — a credit to the welder and to ANACONDA 997 Low Fuming Bronze Rod.

WITH increased production and higher capacities becoming the watchword, horsepower requirements are constantly increasing, too. And where high horsepower ratings and dependable service are musts—you can count on Louis Allis. The Louis Allis motor line is also unusually complete in large motor sizes, 250 to 1000 horsepower.

There's no compromise with Louis Allis quality in these giants of the motor field. All of them include such important features as efficient ventilation, carefully controlled insulation for windings and dependable sleeve or ball bearings. They're built to stand the rigorous demands of high horsepower service —year-in, year-out.

Louis Allis large motors are available in a variety of sizes, types, and enclosures. If you have applications where rugged service requirements must be met, your Louis Allis Sales Engineer will give you complete information.

THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

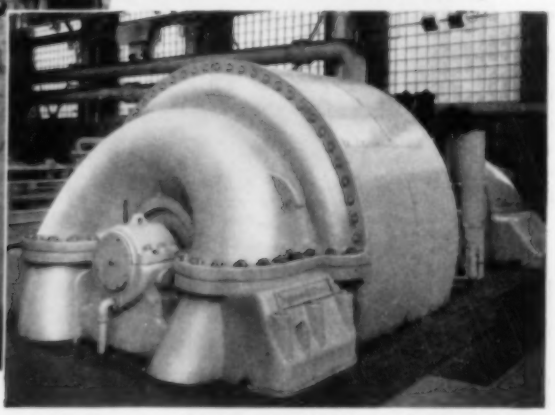


700 H.P. Type OGX
3550 R.P.M. 4160 Volt
Open Drip-Proof Motor

BM-101

General view of blast furnace blowing room, showing the two 100,000 cfm I-R Turbo-Blowers and 11,500 hp I-R Steam Turbines.

Blower end of one of the 100,000 cfm blast furnace Turbo-Blowers.



COMPLETE I-R BLOWER PLANT

helps another large steel mill maintain continuous high production

Like other leading steel producers throughout the country, this large Western Pennsylvania steel mill has placed full confidence in Ingersoll-Rand equipment for the vital blower plant.

Here confidence means more than peace of mind. It means continuous, uninterrupted production of our most essential metal. For any failure of the turbo-blower equipment would mean a costly shut-down of the blast furnace—and a serious loss of plant output.

That's one important reason why Ingersoll-Rand has long been a major supplier to the steel industry—where *proved dependability* of equipment is absolutely essential. An Ingersoll-Rand engineer will be glad to discuss your blower, compressor, condenser or pump problems with you. Call on him whenever he can help you.

Ingersoll-Rand Equipment installed at this Western Pennsylvania Steel Mill

- *Two I-R Blast Furnace Turbo-Blowers,* each driven by an 11,500 hp I-R Steam Turbine and compressing 100,000 cfm of air to 30 lb.
- *Two I-R Surface Condensers* serving the blower turbines. Two-pass, vertically divided, each with 10,000 sq. ft. of surface.
- *Two I-R Vertical Condensate Pumps* for the surface condensers, returning water to boiler recycle.
- *Two I-R Steam-Jet Air Ejectors* serving the surface condensers.
- *Two I-R Turbo-Blowers* for compressing 15,000 cfm of coke oven gas to 10 lb. Each driven by a 700 hp motor.
- *Three I-R Four-Corner PRE Compressors* for boosting coke oven gas to 25 lb. Each driven by a 1250 hp motor.
- *Two I-R Single Stage ES Dry Vacuum Pumps,* 100 hp each, for the desulfurizing unit.

Also many small I-R Centrifugal Pumps in the coke plant.

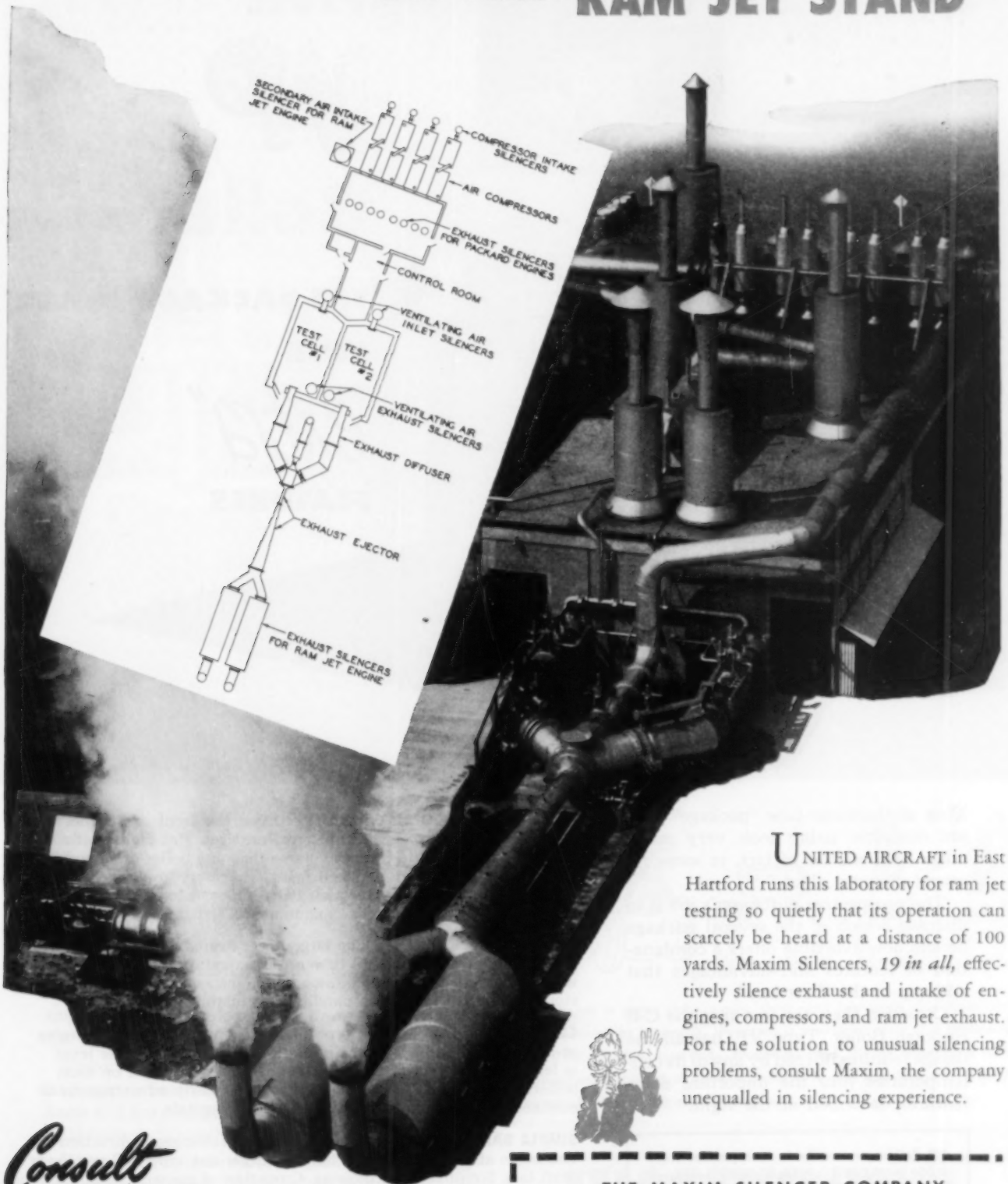
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

896-12

COMPRESSORS · TURBO BLOWERS · CENTRIFUGAL PUMPS · VACUUM EQUIPMENT · ROCK DRILLS · AIR TOOLS

NINETEEN MAXIM SILENCERS ON THIS RAM JET STAND



UNITED AIRCRAFT in East Hartford runs this laboratory for ram jet testing so quietly that its operation can scarcely be heard at a distance of 100 yards. Maxim Silencers, *19 in all,* effectively silence exhaust and intake of engines, compressors, and ram jet exhaust. For the solution to unusual silencing problems, consult Maxim, the company unequalled in silencing experience.

Consult

MAXIM

11MX83

THE MAXIM SILENCER COMPANY
61 HOMESTEAD AVE., HARTFORD 1, CONN.

Gentlemen:
Please send me your bulletins on Exhaust and Intake Silencers.

NAME _____

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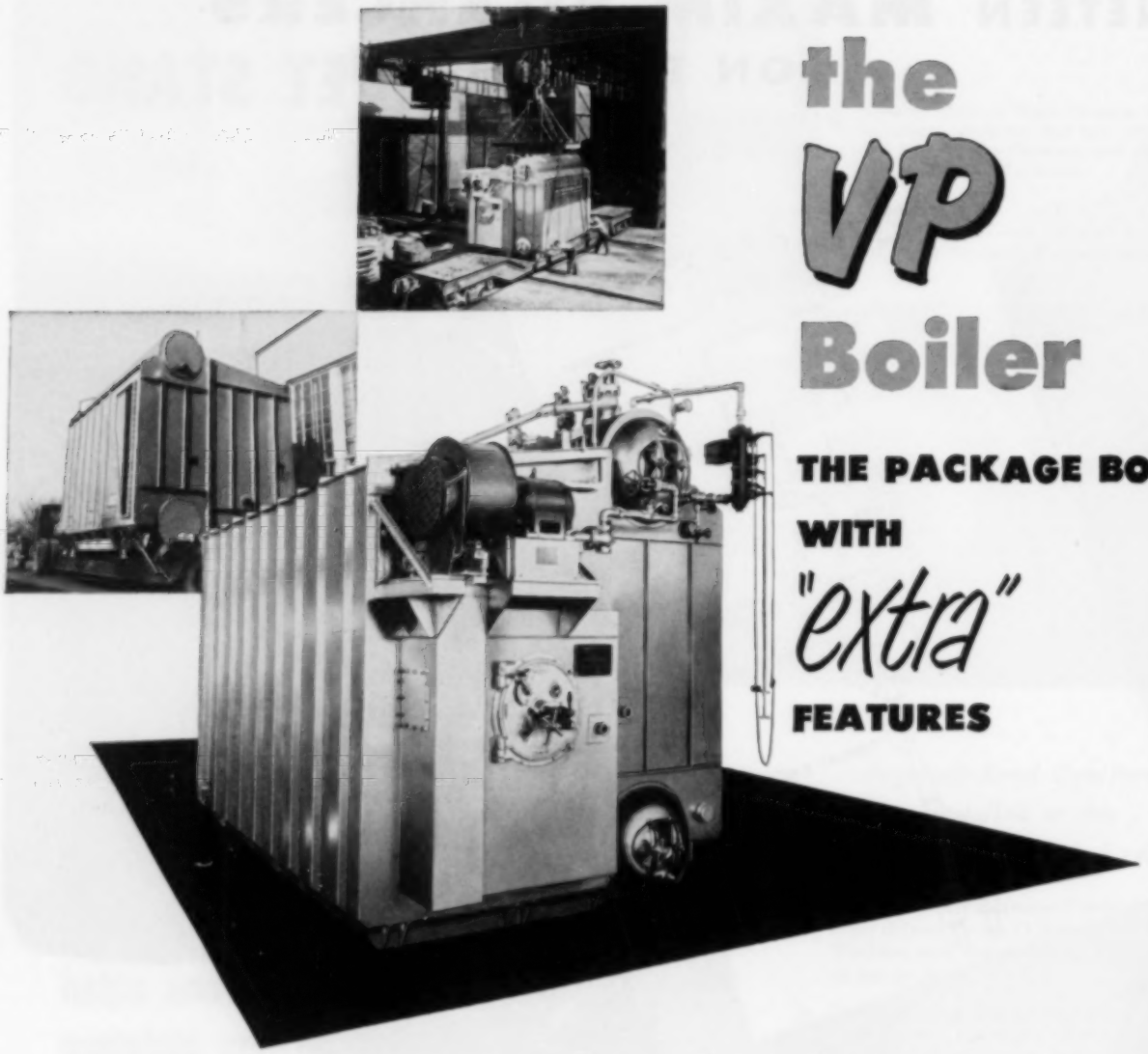


the VP Boiler

THE PACKAGE BOILER WITH "extra" FEATURES

Most of the water-tube "package" boilers available today look very much alike. As a matter of fact, in some respects they are alike.

The prospective purchaser's job is to discover which of the several package boilers now available offers a combination of features and advantages that adds up to the "best buy".

Consider, then, the fact that the C-E Package Boiler, Type VP, has *all* the design features offered by any of its contemporaries *plus* the important extra features described at the right.

VP Boilers are available in capacities from 4,000 to 30,000 lb of steam per hr; pressures to 250 psi. Send for Bulletin VP-24.

FULLY WATER-COOLED FURNACE — Even the front or "burner" wall is protected, except in three smallest sizes. Has higher ratio of furnace-wall cooling to furnace volume than any boiler of its size and type. Assures rapid and efficient heat absorption, lower gas temperatures entering convection bank, reduced tendency to slag formation. Minimizes furnace maintenance.

LARGER LOWER DRUM — The large lower drum, 30″ in diameter, permits simple, symmetrical tube arrangement; provides easy access when necessary for washing down or for inspection; greater water storage capacity facilitates handling fluctuating loads.

CENTRIFUGAL FAN — This type of fan is more efficient, operates at lower speed and is quiet in operation. The average noise level is less than half that of typical high-speed blowers used on most boilers of this type. Low noise level is particularly advantageous in confined space and in such installations as hospitals.

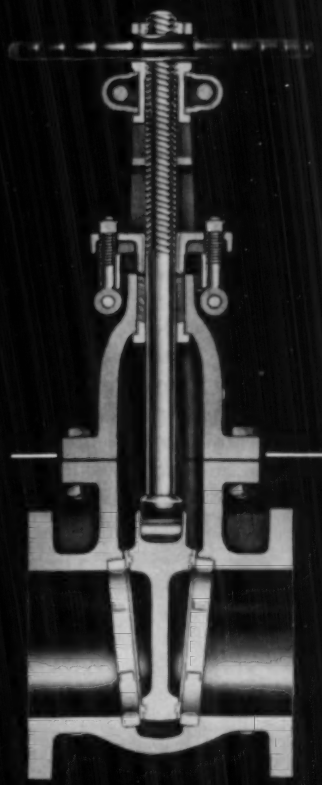
SIMPLE BAFFLE ARRANGEMENT — Minimum changes in direction (no baffle at all in convection bank in larger size units). Gives lower draft loss. Simplifies soot blowing. Cross-flow of gas with elimination of dead pockets gives maximum heat pick-up. Water-cooled baffle in intermediate sizes insures minimum maintenance.

B-6528

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



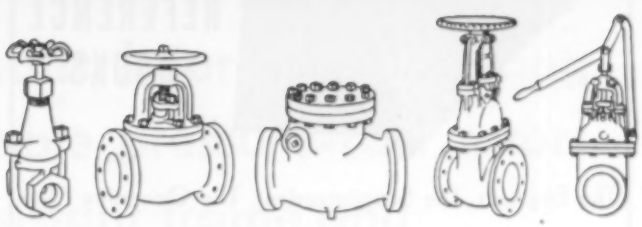
IRON

COMPLETE LINES OF IRON VALVES AND PIPE FITTINGS are manufactured by Walworth in a variety of types, pressure ratings, sizes, and patterns for general industrial use.

Walworth also manufactures complete lines of valves (including Lubricated Plug Valves), and pipe fittings made of steel, bronze, and special alloys.

These valves and pipe fittings, plus Walworth-made pipe wrenches total approximately 50,000 items and are sold through distributors in principal centers throughout the world.

Walworth engineers will be glad to help you with your problems. For further information call your local distributor, nearest Walworth sales office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.



Iron valves in gate, globe, angle, check, and lubricated plug types are manufactured by Walworth. Illustrated is a sectional view of a Walworth No. 726F Standard Iron Body, Bronze Mounted, Wedge Gate Valve with flanged ends. This line of valves is available in sizes 2 to 30 inches. Similar valves of All-Iron type are also available.

WALWORTH

Manufacturers since 1842

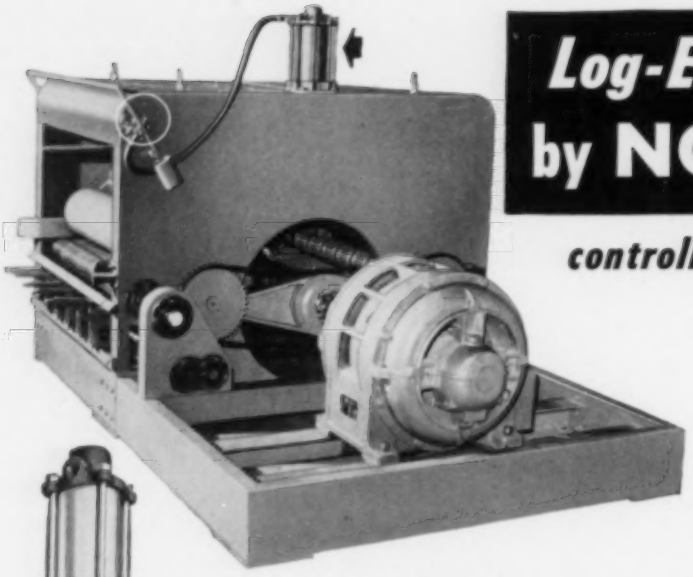
valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Log-Edger Feed-Rolls lifted by NOPAK Cylinder

controlled by NOPAK 3-Way Air Valve



NOPAK Model "D" Air Cylinder for Right Angle Flat Base Mounting, Rod End.

•

Refer to Sweet's File for Product Designers or write for Bulletin SW-1.

This Pacific Coast type log edger, manufactured by Albany Machine & Supply Co., Albany, Ore., employs an 8" NOPAK Model "D" Single Acting Air-Cylinder to lift the heavy feed-rolls by means of lever arms. This permits feeding of various sized cants as required. The cylinder is actuated by a 3/4" NOPAK, 3-Way Air Valve, equipped with lever extension-bar enabling the operator to manipulate it from any point in front of the machine. Weighted valve lever, when released, lowers rolls to "feed" position. Heavy springs prevent the feed rolls from dropping full length of cylinder stroke when machine is "empty."

This comparatively simple application may suggest how you can employ NOPAK Valves and Cylinders in your plant or product to actuate and control machine movements.

GALLAND-HENNING NOPAK DIVISION
2759 S. 31st STREET • MILWAUKEE 46, WISCONSIN

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE
Representatives in Principal Cities

TWO HANDY REFERENCE BOOKS

For
The Engineer, The Superintendent, The Operating Man

Cameron Pump Operator's Data.....$2.00
Cameron Hydraulic Data.....$3.00
or
Both For $4.50.

COMPRESSED AIR MAGAZINE, 942 MEMORIAL PARKWAY
Phillipsburg, New Jersey, U.S.A.

PLEASE SEND ME:
☐ Cameron Pump Operator's Data and Cameron Hydraulic Data. Both Books.....$4.50
☐ Cameron Pump Operator's Data.....$2.00
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☐ Enclosed (Money Order) (Check) for $.....
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Only SAUERMAN OFFERS ALL THESE LONG RANGE MACHINES

Sauerman Scraper stores and reclaims 150,000 tons of stone on space between dock and cement mill.

Sauerman earthmoving machines have been providing efficient, economical materials handling for over 40 years. Moderate in initial investment, they are equally adapted to a wide variety of applications, including bulk and waste material haulage, stockpiling and storage. One man operation, plus long life and low maintenance, insure low cost per cubic yard handled.

DRAG SCRAPER STOCKPILER — Stores and reclaims bulk materials, such as coal, gravel, sand, sugar, ore, and a variety of chemical products. Equally adaptable both indoors and out.

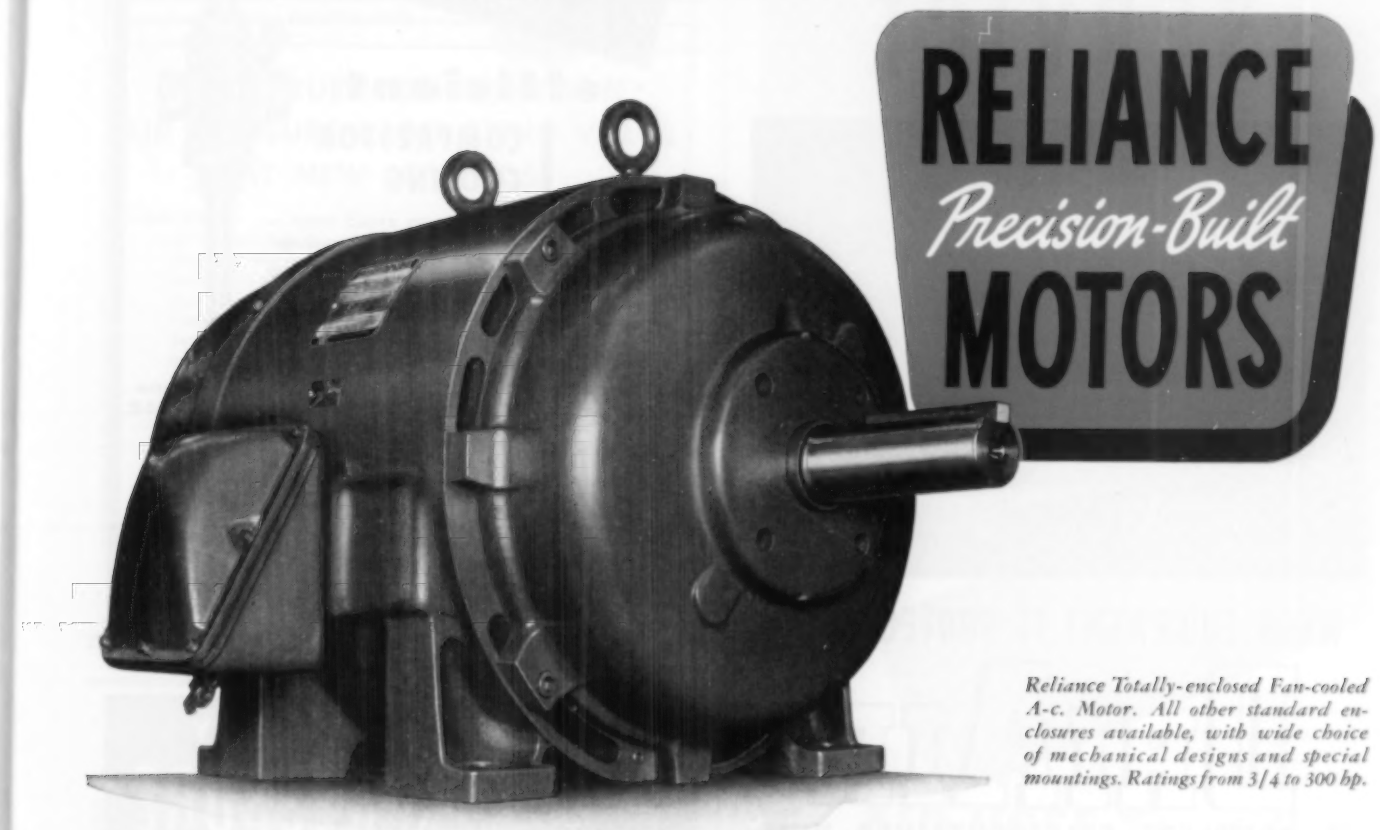
DRAG SCRAPER EXCAVATOR — An economical machine for excavation, reclamation and handling of materials, wet or dry. A rapid conveyor for long range hauling. Bucket sizes 1/3 to 15 cu. yds.

SLACKLINE CABLEWAY EXCAVATOR — Unexcelled for operations that require delivery to a high point. Lifts its load to the top of the plant thirty to forty times an hour.

Sauerman has the size and type machine to do your job. Write for illustrated catalogs. Sauerman Bros., Inc., 548 S. Clinton St., Chicago 7, Ill.

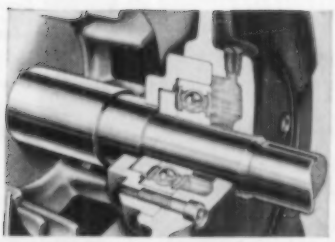
SAUERMAN BROS., Inc.

DEPENDABLE...because they're ENGINEERED FOR RUGGED SERVICE



Reliance Totally-enclosed Fan-cooled A-c. Motor. All other standard enclosures available, with wide choice of mechanical designs and special mountings. Ratings from 3/4 to 300 hp.

- ☆ Heavy shafts, bearing to bearing
- ☆ Indestructible pressure-cast rotors
- ☆ Shock-resistant frame and bearing-bracket construction



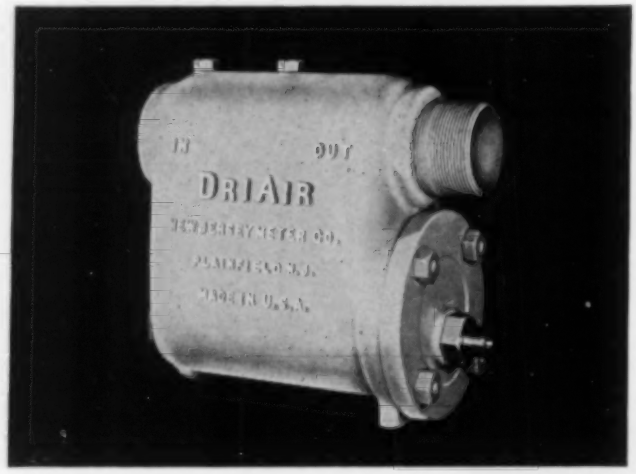
. . . AND THE BEST PRE-LUBRICATED BEARING DESIGN

The Reliance pre-lubricated bearing provides *four times more operating hours without re-lubrication* than any other bearing used in motors today. And—whatever your lubrication schedule—*you just can't grease 'em wrong!* To get the complete "inside story" on motor bearings, write today for Bulletin B-2201. It contains hard facts on the advantages of the Reliance pre-lubricated bearing design, with cutaway view, cross-section diagram, comparison chart, and statements by bearing manufacturers. B-1458

RELIANCE ELECTRIC AND ENGINEERING CO.

1118 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

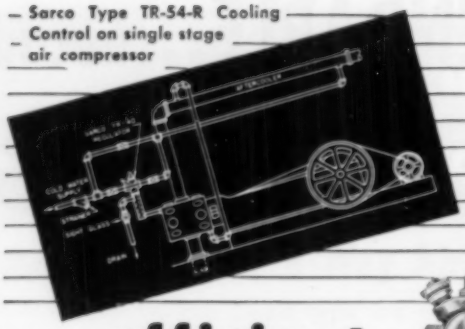
DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

— Sarco Type TR-54-R Cooling
— Control on single stage
air compressor



Sarco TR-54-R

efficient COMPRESSOR COOLING

- Do you want to avoid over — or under — cooling?
- Do you want to save cooling water and lubricants?
- Do you want to increase the efficiency and life of your air compressor? . . . then install SARCO COOLING CONTROLS

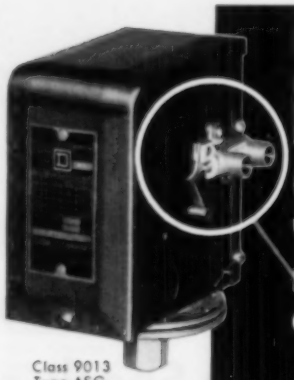
Simple • Self-operated • Inexpensive

Ask for Bulletin No. 701

SARCO COMPANY, INC.

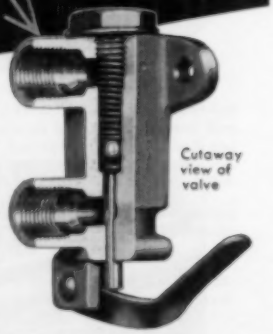
EMPIRE STATE BUILDING, NEW YORK 1, N. Y.
Represented in Principal Cities
SARCO CANADA LTD., TORONTO 8, ONTARIO

518



Class 9013
Type ASG
Form X

HEAVY DUTY PRESSURE SWITCH FOR AIR COMPRESSORS



Cutaway view of valve

COMPLETE RANGE IN 1 CONTROL UNIT

Either 20 to 180 or 25 to 250 PSI.
No spring changes required.

MORE AIR CAPACITY

with improved 2-way ball and "O" ring type valve.

Write for Bulletin 9013A. Address Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin

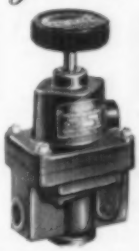
ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

Engineered Air Regulation

KENDALL MODEL 30

Precision Air Pressure Regulator
AVAILABLE ¼" or ⅜" N. P. T.
RANGES 0-10, 30, 60, 100 PSIG
Send for BULLETIN 9523



FIRST TRUE HIGH PRECISION AIR PRESSURE REGULATING VALVE AT NEW LOW COST

FEATURES:
☆ Perfect Balance — complete immunity from upstream pressure changes ☆ Large Flow Capacity (35CFM) — automatic relief — flow compensation ☆ Small Physical Size ☆ Removable Stainless Steel Valve Trim ☆ Deep Convolution Constant Area Diaphragms made by our own Bellofram Division ☆ Aircraft Quality materials and finishes ☆ Adaptable to all types of mounting ☆ New Low Unit Cost

APPLICATIONS:
☆ *Instrument service — internal and external*
☆ *Pneumatic gauges* ☆ *Paint sprayers* ☆ *Machine shop use*
☆ *Diaphragm and cylinder air loading*

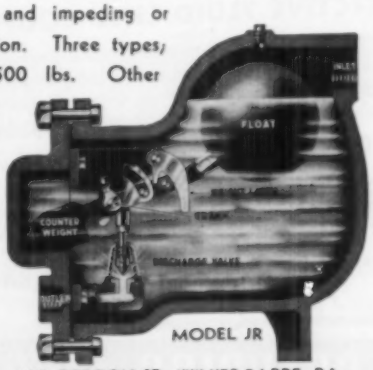
KENDALL CONTROLS CORPORATION
144 MOODY STREET WALTHAM 54, MASS.

New **NICHOLSON**

NON-PLUG AIR TRAPS

Introduce Oil-Eliminating Feature Preventing Build-up of Scum and Sludge

In these Nicholson air traps you enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Three types; pressures to 1500 lbs. Other features: No air - wasting vent. Positive water seal at valve. Large orifice keeps valve clean. For details send for . . .



Bulletin 651

180 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO.
TRAPS · VALVES · FLOATS

"MINE KING"

The AIR HOSE *That Cuts Drilling Costs Three Ways*

Use of "MINE KING" Air Hose assures important economies in drilling operations, regardless of conditions.

Its tougher, more durable construction keeps it on the job longer —a saving in hose replacement costs.

Extreme flexibility provides easier handling and facilitates drilling in tight spots and coiling for transport.

Availability in extra long lengths reduces the need for intermediate connections to an absolute minimum — fewer couplings required — less time for setting up the lines.

"Mine King" is a Goodall "Standard of Quality" product, made in sizes ½", ¾" and 1", double and triple cord, maximum lengths of 500 feet.

Contact Our Nearest Branch for Prices

GOODALL RUBBER COMPANY
GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.
Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles · San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities
Goodall Rubber Company of Canada, Ltd., Toronto.
Est. 1870

TO AVOID AIR LINE PROBLEMS

use the HANSEN man's know-how

...backed by experience in hundreds of plants!

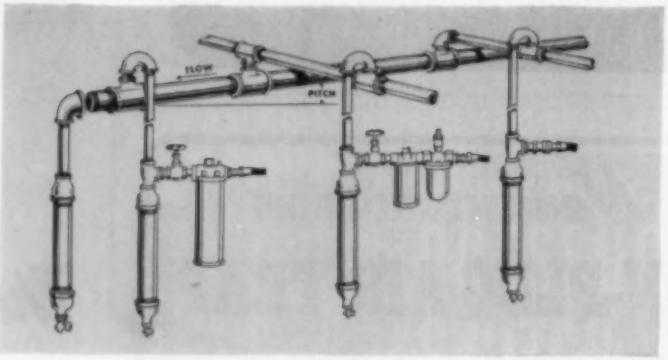
Believe us, you're missing something if you aren't making use of the know-how and help that you can get from the Hansen representative. In dozens of plants, it's almost routine procedure to call him—either when actual troubles arise—or when air line circuits are being planned or altered.

The main job of the Hansen representative, of course, is to supply you with exactly the right couplings for your particular requirements. But from years of on-the-job experience with almost every type of fluid line installation, he can also give you real help on such matters as the pitch of your lines, proper take-off, location of drains and other details which insure a moisture-free circuit operating at maximum efficiency.

THE HANSEN REPRESENTATIVE—

Quick-Connective Couplings Are His Business

BUT SO ARE AIR LINE PROBLEMS



To keep moisture out of air operated devices—
ASK THE HANSEN REPRESENTATIVE ABOUT THE HANSEN HOOK-UP

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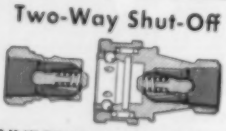
QUICK-CONNECTIVE FLUID LINE COUPLINGS

1. QUICK CONNECTION AND DISCONNECTION **2. INSTANT AUTOMATIC FLOW OR SHUT-OFF**

One-Way Shut-Off

Two-Way Shut-Off



ALSO STRAIGHT-THROUGH QUICK-CONNECTIVE COUPLINGS

Send for Catalog!

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

Air to spare from compressor pair

...with help of TIMKEN® bearings

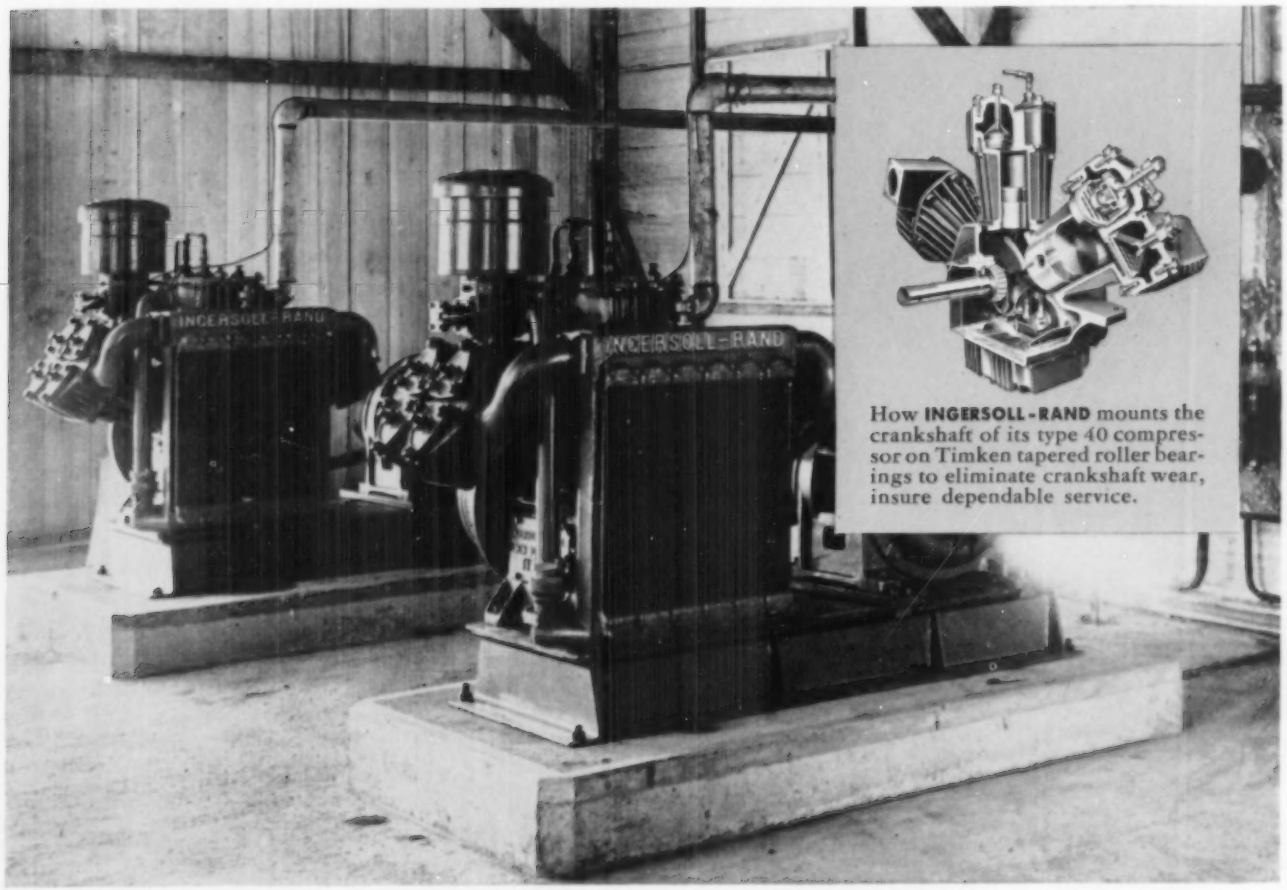
THE twin Ingersoll-Rand type 40 compressors pictured below supply air to spare for quarry and general excavation work. To minimize wear and breakdowns, crankshafts are mounted on Timken® tapered roller bearings.

Crankshafts are held in positive alignment, reducing wear on related parts. Timken bearings hold housings and shafts concentric—making closures more effective. Dirt and moisture stay out—lubricant stays in. Maintenance and lubrication costs are kept to a minimum.

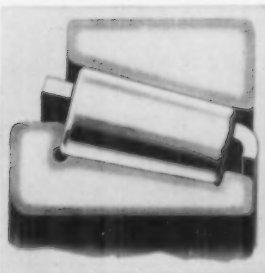
Extra load-carrying capacity is provided by full line contact between rollers and races. Made of Timken fine alloy steel, the bearings normally last the life of the compressor.

Be sure to specify Timken bearings for the machinery you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **INGERSOLL-RAND** mounts the crankshaft of its type 40 compressor on Timken tapered roller bearings to eliminate crankshaft wear, insure dependable service.



HARD ON THE OUTSIDE, TOUGH ON THE INSIDE

Rollers and races of Timken bearings are case-carburized to give a hard, wear-resisting surface and a tough, shock-resisting core. Result: longer bearing life.

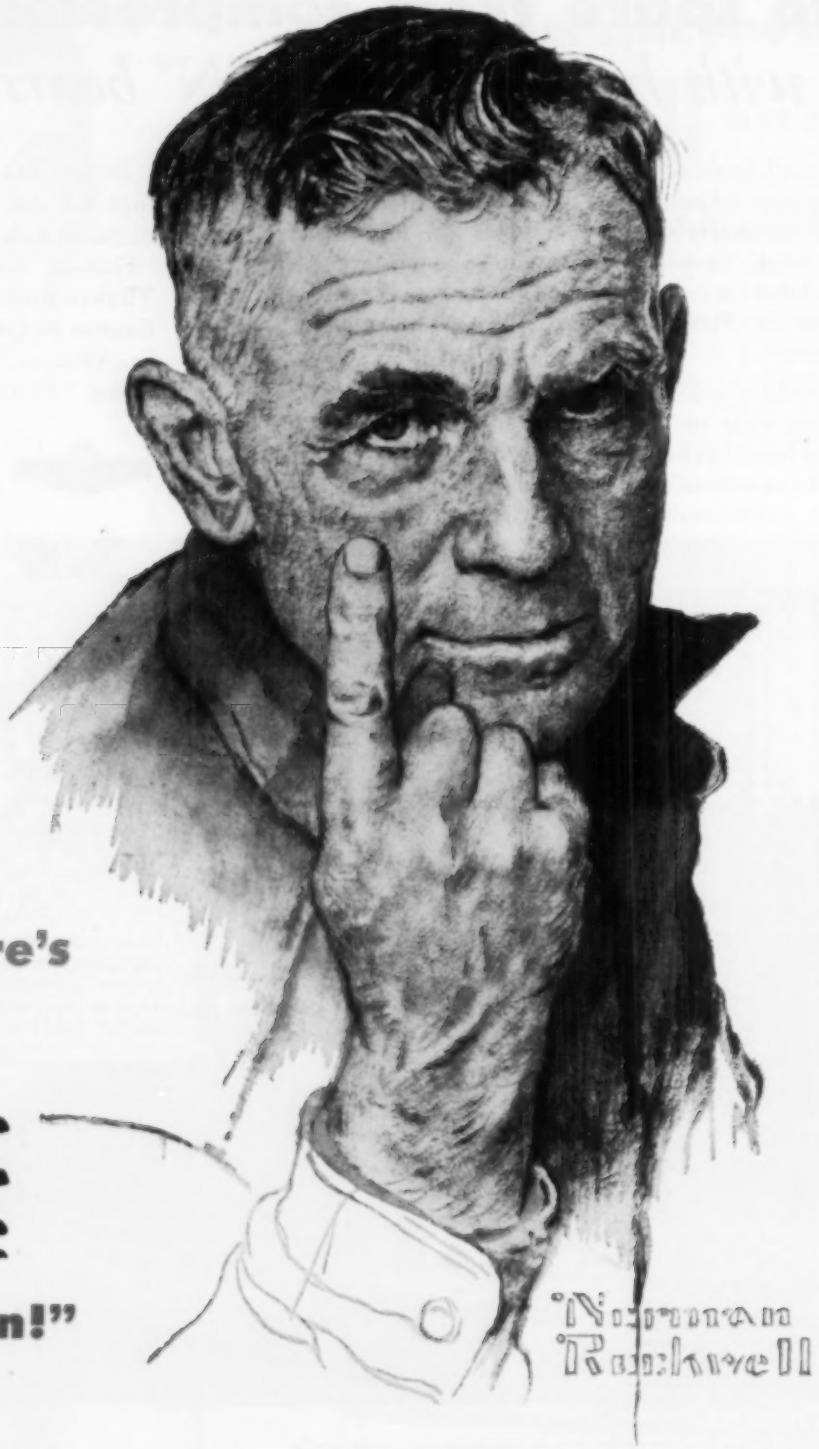
The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis Timken steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▱ BEARING TAKES RADIAL ◫ AND THRUST →◫← LOADS OR ANY COMBINATION →✳←



IT'S JUST THAT SIMPLE. There's only one reason in the world why 2 out of 3 wire rope users in the excavating and construction field prefer Roebling wire rope . . . *it costs a lot less on the job than any other.*

For maximum wire rope efficiency and economy, call your nearest Roebling office for a Field Man. He'll recommend the best ropes for your machines.

ROEBLING CF&I

A subsidiary of The Colorado Fuel and Iron Corporation

JOHN A. ROEBLING'S SONS CORPORATION, TRENTON 2, N. J. BRANCHES: ATLANTA, 934 AVON AVE. • BOSTON, 51 SLEEPER ST. • CHICAGO, 5525 W. ROOSEVELT RD. • CINCINNATI, 3253 FREEDONIA AVE. • CLEVELAND, 13225 LAKEWOOD HEIGHTS BLVD. • DENVER, 4801 JACKSON ST. • DETROIT, 915 FISHER BLDG. • HOUSTON, 6216 NAVIGATION BLVD. • LOS ANGELES, 5340 E. HARBOR ST. • NEW YORK, 19 RECTOR ST. • ODESSA, TEXAS, 1920 E. 2ND ST. • PHILADELPHIA, 230 VINE ST. • SAN FRANCISCO, 1740 17TH ST. • SEATTLE, 900 1ST AVE. S. • TULSA, 321 N. CHEYENNE ST. • EXPORT SALES OFFICE, TRENTON 2, N. J.

COPPUS "BLUE RIBBON" VENTILATORS

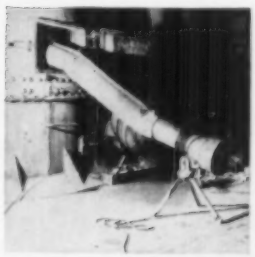
identified by the blue band

FOR WORKERS'

- *Safety*
- *Health*
- *Comfort*
- *Efficiency*

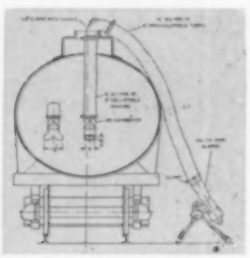
VANO® Design "A" VENTILATOR

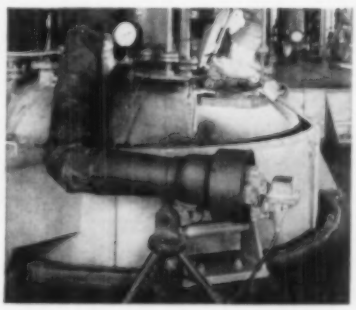
Vano Design "A" cooling interior of furnace, supplying fresh air through 10 feet of "Ventube" to provide safety and comfort during repair work.



Vano Design "A" delivering fresh air to cable manhole, expelling sewer gas, making entrance safe in a few minutes.

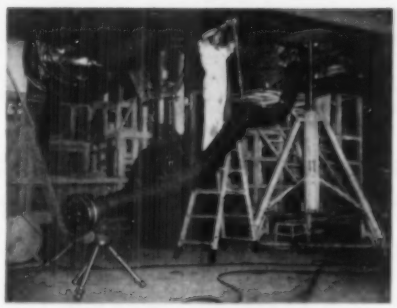
Vano Design "A" Ventilator plus a few accessories feeds large air volume into tank car, driving out fumes, stagnant or hot air for workers' safety and comfort.





Vano Design "A" supplying fresh air in Reactor Room of Synthetic Rubber Plant.

Vano Design "A" Ventilator supplying fresh air to men working in wing compartments, fuselages, etc.



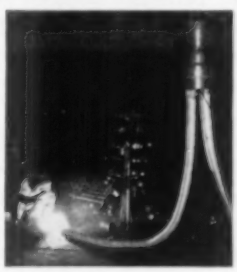
Powered by a ½hp motor, and equipped with the exclusive Coppus axial-flow propeller-type fan, this general-purpose blower delivers 1500 CFM of fresh air. It supplies ventilation for tanks, tank cars, drums, vats, underground cable manholes, pipe galleries, airplane wing compartments and fuselages, and other confined places. Weighs only 103 lbs. Uses 8"-diameter flexible canvas tubing ("Ventube").

VANO
DESIGN "C"

VENTILATOR-EXHAUSTER

Vano Design "C" equipped with 8" discharge tubing removing welding fumes.

Vano Design "C" equipped with two suction lines removing welding fumes for operators' safety.



For withdrawing welding fumes from confined places or directly from the welding rod ...or for expelling fumes or hot air from enclosed vessels. You can get it with 8" suction inlet for 8" non-collapsible tubing ...or with multiple inlet nozzles for 5", 4" or 3" suction hose. The discharge outlet takes 6" "Ventube". Powered by a ½ hp motor, it weighs only 85 lbs.

COPPUS ENGINEERING CORP., 205 PARK AVENUE, WORCESTER 2, MASS.
Please send information on the Blowers that clear the air for Action.

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.

(Write here any special ventilating problem you may have.)

NAME .....

COMPANY .....

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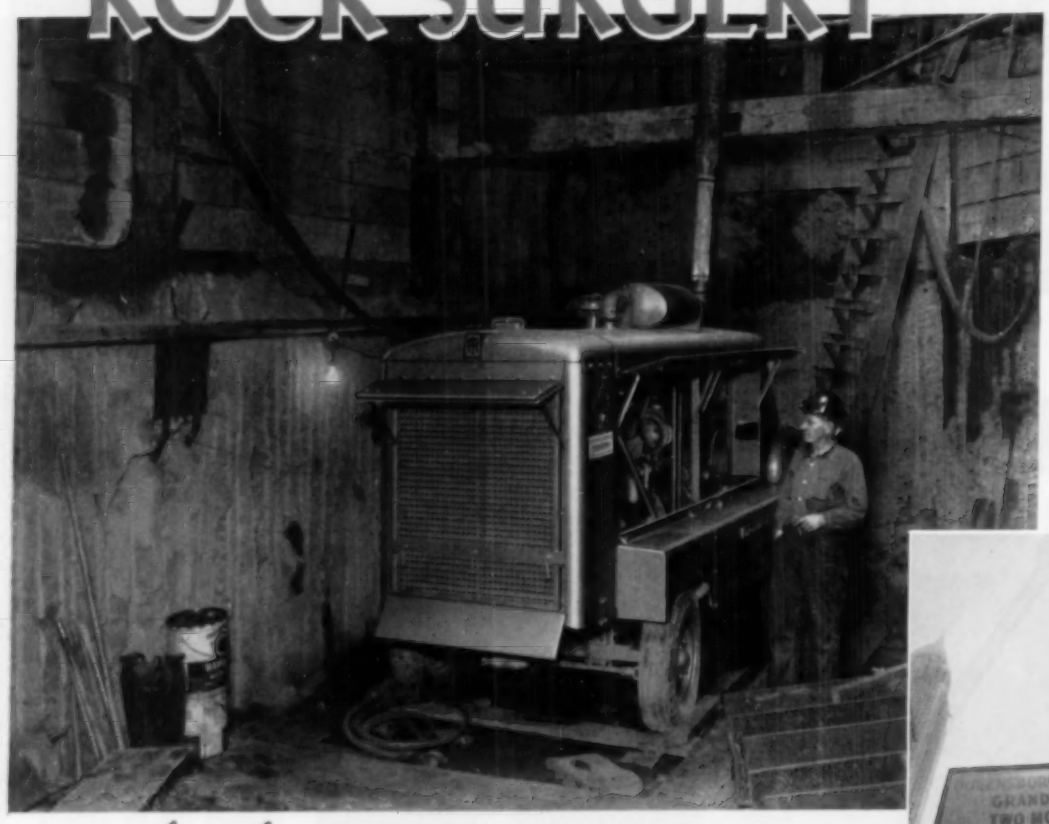
COPPUS "BLUE RIBBON" PRODUCTS—*Designed for Your Industry, Engineered for You*

ROCK SURGERY



The light weight (only 9500 lbs) and extreme compactness of Ingersoll-Rand's 600-cfm GYRO-FLO Rotary Compressor made it a simple matter for a crane to lower it into the cramped underground working-pit from which it supplies air to all pneumatic equipment.

in the heart of MANHATTAN

GYRO-FLO Compressor helps foundation specialists probe the "innards" of New York's underground.

Heavy surges in pedestrian traffic create a dangerous bottleneck in stairway-ramps and elevators serving the subway lines at Grand Central Terminal. Studies by the Board of Transportation of New York City indicated that a double escalator could relieve this congestion. But the area was teeming with humanity, and already crammed with tunnels, partitions, skyscraper foundations, gas mains, water pipes, sewers, and electrical cables. How to make the necessary excavations for the Board of Transportation was the problem undertaken by the firm of Spencer, White and Prentis, Inc.

Their first step was to open a pit, 50 x 20 feet and 32 feet deep, in 42nd Street at the base of the 50-story Chanin Building. This involved demolition of the flint-hard masonry of existing structures by the plug and feather method using Ingersoll-Rand J-50 Jackhamers and L-54 Paving Breakers. The working area was decked over except for an 8 x 15-foot hole through which all equipment was lowered and all broken rock raised by crane.

From this pit, which housed a 600-cfm GYRO-FLO Rotary Compressor, excavation of the tough mica schist inched downward at a 30° angle. A unique set-up mounting two I-R DA-30 drifters on an aluminum cross-arm supported by an aluminum column was used. The inclined tunnel leveled out after 45 feet and continued on a horizontal plane for 40 feet more. Several lateral connecting tunnels further complicated the job.

An unusually large number of holes were drilled so that the rock could be broken with very light explosive charges. Blasting was limited to certain short periods which missed traffic surges and the sleeping hours of guests in nearby hotels.

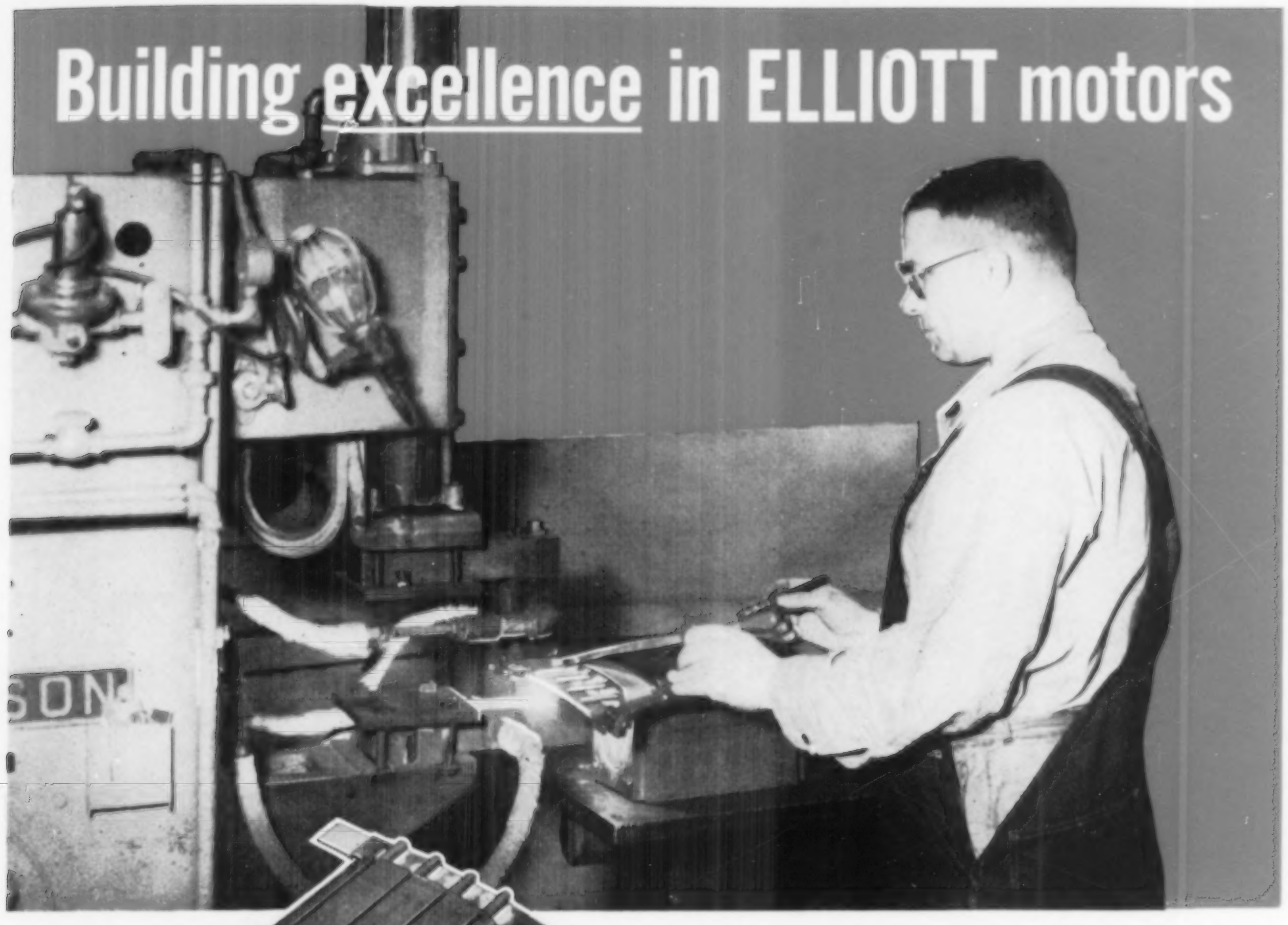
By this ingenious use of modern rock drilling equipment, Spencer, White & Prentis has kept ahead of schedule on this ticklish job. While your undertaking may not be quite so delicate an operation, chances are that GYRO-FLO compressors and I-R rock drills can help you maintain your schedule. A call to your nearest I-R branch will speed complete details to you.

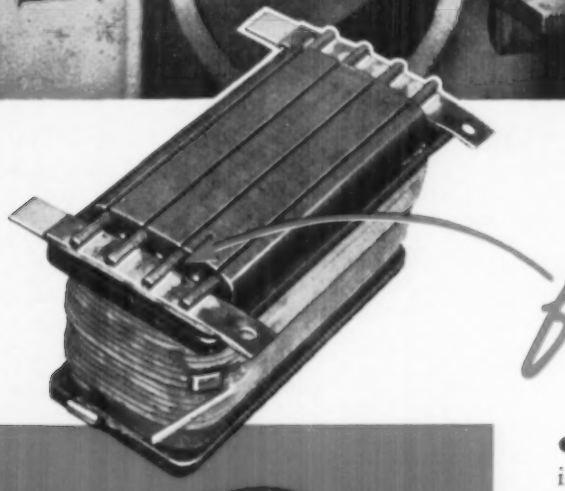
Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 862-2

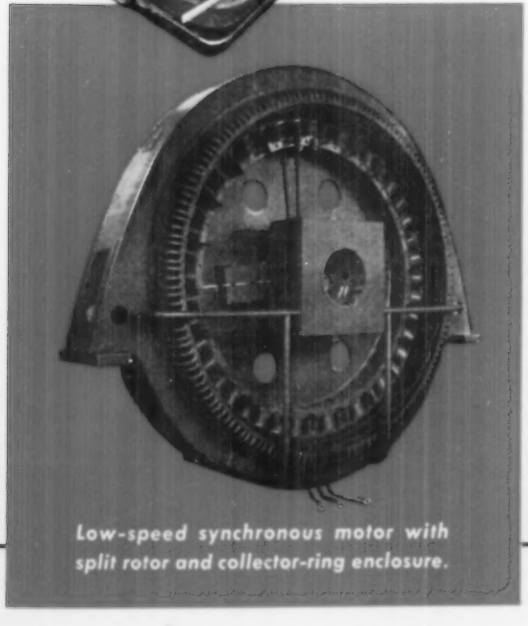
COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

Building excellence in ELLIOTT motors





Silver brazing for permanence!



Low-speed synchronous motor with split rotor and collector-ring enclosure.

● Damper bars of Elliott synchronous motors are individually silver brazed to broad end-ring segments by the resistance brazing method. The brazing alloy is fed in and flowed along the length of both sides of the joint, forming a long, thick low-resistance, high-strength fillet. Graphite electrodes clamp the bar to the end-ring until the silver brazing alloy solidifies. The special jig shown accurately locates the end-ring segment with relation to the damper bars and pole-piece.

For data on the complete line of Elliott large motors, consult your local Elliott engineer or write Elliott Company, Ridgway, Pa.

ELLIOTT Company

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.

R3-7

A good suggestion for COMPRESSOR LUBRICATION

CLEAN, EFFICIENT air compressor performance depends on effective lubrication. But lubrication can be effective only when it meets the special requirements of the operating conditions. No *one* oil can do a proper job under *all* conditions.

That is why there is *a complete line* of Texaco air compressor oils. Regardless of your operating conditions, or the type or size of your compressors, you can always get a Texaco air compressor oil that will assure the best performance and keep your operating costs low.

Let a Texaco Lubrication Engineer survey your compressor set-up and help you select the proper oil. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

☆ ☆ ☆

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Air Compressor Oils

FOR ALL OPERATING CONDITIONS

TUNE IN: Tuesday nights on television—the TEXACO STAR THEATER starring MILTON BERLE. See newspaper for time and station.